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Crop Protection

WORLD CROPS

The International Journal of Agriculture

VOLUME 9, No. 11 NOVEMBER 1957

A Publication of The Leonard Hill Technical Group

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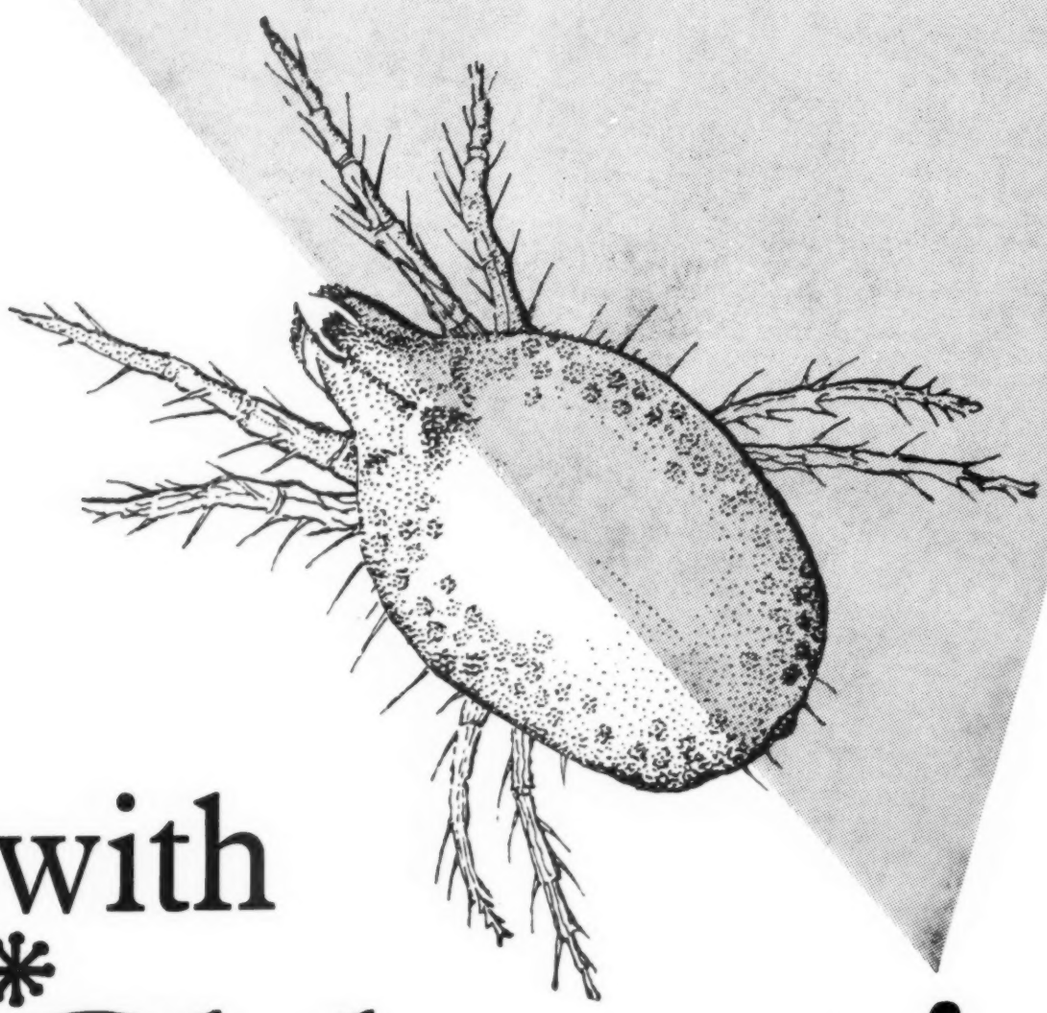

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WORLD CROPS

Editor: Frank Cooke, A.R.C.S., B.SC., A.M.I.CHEM.E., E.D.

Vol. 9, No. 11 — NOVEMBER 1957

CONTENTS

Editorial Comment 437

The Termite: Part I—A Social Insect—*W. Wilkinson* 441

Penetration of Insecticidal Smokes into Model Nests—*W. A. Taylor and G. M. S. Duff* ... 444

The Biological Control of Noxious Plant Species in Hawaii—*Alan Thistle* 447

Oil Aids Agriculture 449

Introducing a New Crop Protection Chemical—*E. Holmes*, M.SC., PH.D., F.R.I.C. 451

Concentrate Spraying—*G. J. Rose*, B.SC., F.R.E.S. 454

The ABC of Weed Control 457

Pyrethrum—Nature's own Insecticide 460

Progress in the Dominican Republic 462

New Publications 464

Machinery and Equipment 467

Agricultural Chemicals 471

World Crop Reports 473

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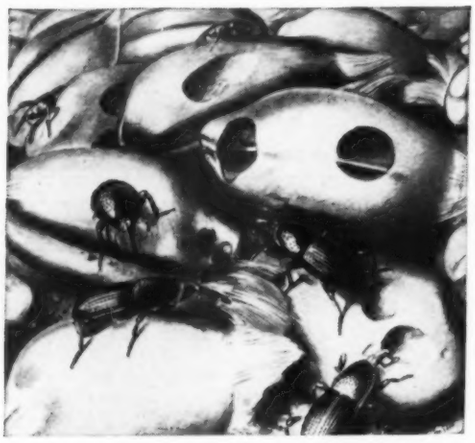
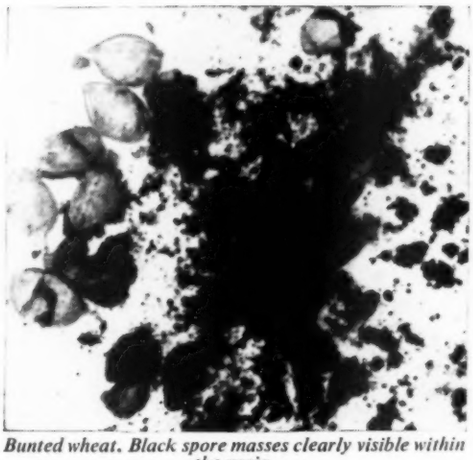
Protects stored grain against pests and moulds suppresses seed- and soil-borne diseases



Grain weevils eating stored grain (much magnified)



Bunted wheat. Black spore masses clearly visible within the grain.

'Mergamma'S protects without affecting germination

'Mergamma' S is the new dry seed dressing that protects stored seeds of wheat, barley, oats, rye, rice and maize against insect pests (such as weevils and moths) and against damaging moulds. It remains effective for a period of twelve months. *Germination capacity is not affected in any way.* 'Mergamma' S prevents seed decay and also protects the seed, after it is planted, from seed- and soil-borne diseases which would otherwise destroy or damage seedlings. 'Mergamma' S ensures a stronger and more regular stand of seedlings and consequent higher yields.

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A UNIQUE PATENTED CHEMICAL

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BARLEY	Covered smut · Leaf stripe · Net blotch	**SORGHUM**	Kernel smut Leaf spot
RYE	Bunt · Stripe smut	**GROUND-NUTS**	Black rot Foot rot
OATS	Covered & loose smuts Leaf stripe	**JUTE**	Stem rot
RICE	Foot rot · Leaf spot	**SUGAR BEET**	Black leg

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Editorial Comment

Bees and pesticides

THE PROBLEM of protecting bees from toxic materials used to control pests, insects or weeds, is not a new one, but it has been made more complex by the variety of chemicals now used. In Britain a recent report from the Ministry of Agriculture's Bee Disease Advisory Committee discussed several cases of suspected bee poisoning attributable to modern insecticides, and in one case to a selective weedkiller. It is certainly possible to argue that some of the recommendations that are given to reduce risks to bees when these substances are sprayed have not been based upon enough field experimentation. Experimental studies under somewhat artificial conditions for bringing bees and these toxic substances together may not always be an adequate basis for recommendations or assurances that a particular chemical is harmless.

An interesting example of this comes from New Zealand, where field tests by Government research officers have definitely shown a new systemic insecticide to be highly poisonous to bees when used close to plant-flowering time. This was established, although the manufacturers had stated that its use involved no hazard to bees if applied correctly, *i.e.* with no direct contact between bees and the spray itself.

It seems that the test data on which this statement has been based were inadequate for predicting field results. When the systemic insecticide was sprayed on 11 acres of kale in flower virtually all field bees working on the crop were dead within two days and the nectar in the flowers was still toxic to bees after five days. Also, all bumble bees visiting the crop were killed, and, as these were queens that had started to build up nests, their losses meant a loss of an equivalent number of colonies. Yet the insecticide concerned was supposed to be absorbed by plant tissues within two hours of spraying, and so, if sprayed late in the day to flowering crops, *i.e.* after bee flight is over, no risk to bees should have existed by the next morning.

The New Zealand work has emphatically shown that this systemic insecticide, though one of especially low mammalian toxicity, should not be applied to crops any later than a fortnight before flowering time.

Gardens and middens

WE HAVE all heard of the human ant—the popular name for the rock climber—but ants, too, can be human. There is a family of ants, only to be found in tropical and sub-tropical South America, which leads a purely agricultural life in that they cultivate gardens, dispose of unwanted refuse in middens and have cemeteries for their dead.

They are the leaf-cutting ant, *Atta* spp., which do tremendous damage to maize and to fruit crops in that they cut off the leaves and carry them back to their nests. Here they chew the leaf to pulp, on which they feed a fungus. This is known as a fungus garden (see article on page 444).

There are a number of these gardens in the form of caves, the size of a football, which are to be found in the extensive subterranean nests of these ants; the entrance to the garden is at the bottom and not easily accessible from above.

The ants weed the fungus garden to obtain a pure culture and they prevent the fungus from fruiting by detaching the fruiting bodies, which are discarded. Turnip-like swellings are produced at the ends of the *hyphae*, known as *bromatia*, and it is on these ' turnips ' that they live.

At the very bottom of the nest there is a midden of considerable size, sometimes even large enough for a man to stand in it. Into these sewage pits they throw the alien fungi, any undesirable portions of their feeding fungus and also bits of stalk and unusable leaf. Finally, into these pits they tumble their dead.

Research or demonstrations?

NOW THAT Dr. H. L. Richardson's paper on fertilisers in the Far East has been published by the Fertiliser Society (1957, *Proceedings No.* 41 *Fert. Soc.*), the discussion as well as the paper itself is available. In the discussion one of the most interesting contributions came from Mr. H. L. Page, formerly of Rothamsted; he was able to report that in India the surest method of developing ' fertiliser-consciousness ' and fertiliser use among peasants and small-acreage farmers was to carry out fertiliser experiments and demonstrations on the spot, on the actual soils of the farmers. Results obtained at official experiment stations were treated with scepticism and, even if accepted, the view was taken that the research station had unlimited resources and could afford to experiment to an extent that ordinary cultivators could not. In short, ' remote ' science fails to pay off. In sharp contrast, demonstration plots on peasant farms brought impressive results, especially after the first year. Usually the first year was watched without much enthusiasm, but by the second and third years a widespread demand for demonstrations on other farms in the district invariably developed. In some cases the local adviser would even be accused of favouritism in his selection of land for a demonstration plot. Mr. Page believes that this educational approach is likely to produce phenomenal increases in India's use of fertilisers during the next few years.

It might be presumed that this superiority of the simple demonstration plot is more likely in a technically backward country, but there is plenty of reason to believe that the same principle applies fairly generally. Research plots today are run with various complexities —factorial replication, statistical analysis of data etc.— and to the practical mentality of most farmers the eventual results have a somewhat 'highbrow' background. It is certainly difficult to use this type of research evidence for educational purposes without a considerable degree of popularisation. The straightforward demonstration plot, though it risks errors of misinterpretation by lack of replication, is neither remote nor complex. Good effects can be seen for themselves, and the sceptical argument that what can succeed in some other district cannot do so in one's own is swiftly demolished.

What Mr. Page has said about India is confirmed for one of the world's most progressive agricultural countries, Denmark, in a recent OEEC publication, 'The Effective Use of Fertilisers'. Local field experiments were extensively carried out in Denmark in 1900, and today some 3,000 such experiments are annually carried out. They have played, and still play, a great part in establishing the high rate of fertiliser use in Danish agriculture.

In the September issue there was an account of an ambitious scheme of research and demonstration plots for coconuts undertaken by a commercial organisation, Potascheme, of Madras, India, which is designed as a co-operative experiment.

Fertiliser placement

THE PROBLEM of improper fertiliser placement with row crops is not a new one. However, according to the International Potash Institute, it is becoming decidedly more serious.

Despite the fact that we are using approximately two and a half to four times the amount of plant food per acre today as we used 20 years ago, placement methods have changed little with most crops. With some exceptions, farmers are still using equipment and techniques which allow much of the fertiliser to come in contact with the seed at planting. It is obvious from the nature of salt injury why the problem should become increasingly severe when the rate of fertilisation is increased.

Many people have blamed concentrated or high-analysis fertilisers for the increasing amount of fertiliser damage, but concentrated fertilisers as such are not necessarily responsible for this difficulty. In fact, there is usually less damage from high-analysis than from low-analysis fertilisers where equal amounts of plant food are used.

The real cause of the trouble is the fact that there has been little improvement in placement methods as rates of fertiliser usage have increased.

Britain's grassland

THE GOVERNMENT'S action in forming a Grassland Utilisation Committee is an indication that the development of Britain's grassland resources has been disappointingly slow during the post-war years. There have been many exhortations and a number of economic incentives, such as grassland ploughing-up grants and the new grants towards silo costs. An indication of the slow rate at which grassland has been improved in the U.K. is the persistently high cost of feeding-stuffs.

The appointment of Sir Sydney Caine, Director of the London School of Economics, as chairman of the Committee underlines the economic background of this subject. Similarly, the technical background is emphasised by the name given to the Committee—not 'Grassland Improvement', but 'Grassland Utilisation'. For there is nothing difficult about improving quality and output of grassland—attention to drainage, use of fertilisers and lime, surface treatments for permanent grassland etc., these are well-known and well-tried methods. The crux of the problem lies in using the extra grass at the right time and not letting it become fibrous and nutritionally inferior before it is consumed *in situ* or it is cut for preservation in some form as winter feed. Most of the indecision about using grassland more effectively has centred around this question of utilisation.

In recent years, case after case has been reported of individual farms where striking progress has been made, and even small-acreage farms have transformed their financial budgets. With such evidence it seems easy to indict other farmers for not following their examples. The continued persistence of hay-making makes poor comparison with the slow development of silage production and such apathy is difficult to understand. Other obstacles to progress can, however, be better understood. Falling returns for milk coincided with the rapid attainment of the national milk production target and this has discouraged long-term planning for better productivity. There has also been some tendency for animal disorders like bloat and hypomagnesaemia, said to be associated with grazing ley grassland, and it does not require many cases of loss in particular areas to counteract the stories of success. So far in the drive for greater use of grassland, farmers have been told too much about milk output and too little about stock maintenance. Extreme weather variations in recent years have also not been very helpful. Dry springs have checked the growth of grass even where improvement measures have been applied and wet summers have produced surpluses of growth even on unimproved grassland acres.

The new Committee will be able to co-ordinate all these problems. The case for making more effective use of grassland has always been a powerful one, and the pros and cons need to be sorted out.

The rival world

IN THE realm of agriculture the use of fertilisers, weed-killers, insecticides and other chemicals has resulted in crop yields increasing enormously. The scientists who developed these new materials and the manufacturers who are making them available are bringing about a revolution with far-reaching consequences. For the first time in the history of our planet, Man is turning the tide in the never-ending war against what the Shell Chemical Co.'s brilliant film called ' The Rival World '.

We tend to think of the world as ours, but actually human beings are in the minority. Were we all to disappear tomorrow, the majority of the inhabitants of our planet would continue their lives as if nothing had happened. In the rival world of the insects, weeds and bacteria there is no distinction between what is ours and what is theirs. To them food is food, and it is of no consequence to them that, if they eat well, we may not eat at all. It has been suggested that roughly one-third of everything the farmer grows is lost to the depredations of insects, diseases and weeds.

Goats—a pest?

FROM TIME immemorial the goat has been a problem, because he is difficult to control and is a vicious destroyer of plant life. The Bible speaks disparagingly of goats. The goat is not merely a consumer of bark; he pulls up plants by the roots and is one factor in the production of deserts.

It is considered by some that goats were a factor in the downfall of ancient Greece, as after their introduction they soon spread to the forest-clad hills, where they destroyed the saplings and, as a result, the forests disappeared within a few years. The rapid release of rainfall from the bare hills turned the lowlands into swamps, malaria became prevalent amongst the populace and this it is said led to the gradual passing of power to Rome.

It is said that the historic cedars of Lebanon will disappear in due course because goats cannot be kept out of this area.

The tea planter in India has much to put up with, and one of his major worries is goats, as no ordinary fence deters them. If cows get into a tea field they certainly damage the bushes by forcing their way between them, but if grass is to be found below, as is usual, except at the end of periods of drought, they graze on the grass and leave the tea alone. Not so the goat; he not only has a liking for young tea leaf, but apparently he injects something into the bitten stem which causes the shoot to die back. Goats can kill tea saplings merely by nibbling the young leaves.

In the face of this abuse, it is a change to find someone saying a good word for the goat. The *Agricultural Newsletter* from the Netherlands of April/May 1957 records that there are 25,000 to 30,000 goats in that country and improvement of the stock by natural selection is now under way. Goats, it may be noted, are kept mainly by smallholders.

Goat's milk is preferable to cow's milk, especially for young children, because the casein is more finely flaked and consequently more easily digested. On the average, goat's milk is kept in the stomach for only 40 minutes against two and a half hours or more for cow's milk. Moreover, goat's milk is richer in organic phosphoric acid and in vitamins C and B_1. There is little tuberculosis amongst goats, so that the milk can safely be consumed fresh. The average yield of goat's milk in Holland during 1955–56 over a period of 293 days was about 180 gallons, with a butterfat content of 3.85%.

The food requirement of the goat is small, hay in winter and fresh grass in summer, supplemented by fodder-beet, marrow-stem kale, other stubble crops and kitchen refuse.

Still, it would be of interest to learn how the persistent and determined goat tackles the live wire which so effectively keeps the docile cow within a grazing area, and how the pastures and hedges are maintained in the face of his destructive habits.

The language barrier

Go to, let us go down, and there confound their language, that they may not understand one another's speech.—
The confusion of tongues at Babel (Genesis **xi,** 7).

IN THOSE far-off times only one tower was under construction and it was never completed; today, speaking metaphorically, there are at least five—the organisation of world peace, the development of nuclear energy, of aeronautics, and of the related sciences of plant nutrition and plant protection. These are being built up and extended at a truly astonishing speed; the last two (with which we are principally concerned) have developed progressively only during the last 50 and 15 years, respectively—mere specks in the passage of time.

The 3rd International Fertiliser Congress and the 4th International Congress on Crop Protection were both held in Germany during the same week in September. The first was attended by some 650 participants from 35 countries and the other by over 2,000, coming from no less than 75 countries. In this sense, both conferences were highly successful, but such embarrassing success carries with it an enormous responsibility for the host country.

The official languages at both conferences were German, English and French, but the technique was different. With fewer numbers and a restricted programme it was possible at the Fertiliser Congress to hold all the meetings in a single large hall—the Stadthalle of old Heidelberg—to arrange instantaneous translation of the successive addresses and to broadcast in three languages by using headphones; in addition,

there were interpreters with technical experience to explain the proceedings to the press of foreign countries and summaries of the principal addresses were also available in three languages. The broadcast system was not entirely successful, because of the complex and technical nature of the subjects, the rapid delivery of some of the speakers, the highly technical expressions used and the special linguistic difficulty of the German language, in which the verb comes at the end of the sentence.

With an enormous field to cover, the proceedings of the Crop Protection Congress held in Hamburg had to be decentralised and the 22 sections met in eight places, some of which were at a considerable distance from the reception centre, so that it was not possible to hear a selection of papers in the different sections. There was an enormous programme of 386 papers, as against 12 at Heidelberg, and the instantaneous translation of the proceedings with headphones at each centre was a financial impossibility.

Summaries of most of the papers presented to the conference were provided in book form—an excellent publication of some 244 pages. This, unfortunately, did not help much, as the authors were left to decide for themselves in which of the three official languages they would submit their summaries. In almost all cases *this was the same language in which the paper was given to the conference.* In a few cases, however, a verbal summary was given by a speaker in the other two languages, but this was the exception rather than the rule. In addition, no interpreters with a technical background were available and translations of the principal speeches and the press communiques were only available in German. It is obvious that there must be a very considerable time lag before adequate publicity can be given to these two very important conferences —see also WORLD CROPS, 1957, **9**, 181.

It is apparent that the law of diminishing returns is beginning to operate, making it increasingly more difficult to consolidate the rapid advances now being made in these important fields of science. Otherwise expressed, the larger the attendance, the greater the number of participating countries and the more the subject expands, then the less is the value of the conference to the individual participant.

The lessons of these conferences are (1) the efficient administration of the conference is just as important as the arrangement of the scientific programme; (2) the proceedings should be held under one roof, and if decentralising is unavoidable the sections should at least meet in the same building; (3) the scope of these conferences needs to be much more restricted—the possibility needs to be considered whether the main branches of these expanding sciences should not be dealt with in turn on a four-year rotation rather than all together in the same year. The possibility should also be examined as to whether papers could not be grouped and summarised, and the summary read in three languages by selected speakers.

Lecturers dealing with a highly technical subject have a duty to their audience: they should speak slowly, in short sentences and with frequent pauses to allow the broadcasting interpreters and a very mixed audience time to translate and absorb the ideas. They should forget their personal prestige and not try to pack too much into a single paper. A single idea put over in colloquial language and relieved by slides can be much more successful than a highly involved paper of considerable length which has to be read at speed because of restrictions of time.

Indeed, the most important function of these conferences is to bring people together to discuss their business and their work with the representatives of many nations. Those having only a rusty or a colloquial knowledge of another language are, of course, reluctant to engage in a highly technical conversation, and this adds to the natural reserve and instinctive shyness between nations. This can be broken down by engaging technical interpreters from the libraries of large commercial undertakings, such as Verkaufsgemeinschaft Deutscher Kaliwerke G.m.b.H., of Hanover, and by calling on the lecturers to help by providing summaries of their papers in several languages and by all the participants wearing small coloured brooch-buttons to indicate languages with which they are conversant, *e.g.* German, Arabic and Hindustani; German, French and English, and so on.

A world language

WE WOULD suggest that with the rapid advance of science and technology there is an urgent need for an international language to be taught in every school in the world in order to destroy the language barrier and so ensure steady progress in all countries. *The gap between the more advanced countries and the poorer countries is widening and the language barrier is largely responsible.*

This is a subject which has been studiously avoided by the United Nations, but sooner or later it will have to be tackled. The problem is urgent because it will obviously take ten years before it can even begin to take effect, but a start must be made if the story of Babel is not to be repeated in our time.

International recognition for a single world language will mean that fewer languages need be learned and the change-over will be no more impossible than the proposed change from the inch to the metric system. It is advised that during the period of general education, only the mother tongue and the world language should be taught. Subsequently, those selected for a classical education could learn other languages, while those selected for training in science or technology should continue only to use the world language, which might be English, Esperanto or some relatively simple language, such as Malay, to which scientific terms could be added.

THE TERMITE

Part I.—A Social Insect

W. WILKINSON
(*Termite Research Unit, Port Harcourt, Nigeria*)

Termites live in many different types of dwellings and have a family life and a caste system of their own. Part II will deal with the damage caused by these insects.

The mushroom mound of a humus-feeding, forest-dwelling species of Cubitermes—*near Benin, Nigeria*

TO those who make a study of insects the word ' termite ' has a precise significance, as the common name of one of the score or so of orders into which the class Insecta is divided. Far more widely recognised, particularly among those who live in the tropics, will be the term ' white ant '. Nevertheless, there are many termites which are not granted the distinction of being a white ant and, conversely, some pests which are often called white ants are undoubtedly not termites.

It is not only this looseness of definition which leads entomologists to avoid the expression ' white ant ', but also the implication of a relationship to the true ant. In point of fact, the two are no more nearly related than are kangaroos and men. The termites' nearest living kin are the cockroaches, and the precursor of both these ancient branches of the animal kingdom was probably in existence when the coal measures were laid down. Beside them the ants are comparative newcomers, and man himself a rank upstart. The misleading name doubtless originated because of the development in both ants and termites of highly integrated societies, and because of the thin, pallid skin of many of the latter group.

The family unit

Although these societies—known as ' colonies '—are often very complex in organisation and behaviour, the course through which they must have evolved is fairly apparent. The first stage would be a tendency for the parental pair to remain with their eggs and brood. This phase is not uncommon among insects today. For instance, certain earwigs may be found in family groups for no very obvious reason. The process of elaboration from this simple social beginning would be gradual and continuous and doubtless included forms which failed to establish themselves.

Soldiers and workers

Following the gregarious habit, the early termites attained a condition where no doubt exists as to the benefit derived from such a life. A proportion of individuals have become specialised for the defence of the colony, being adapted not only in the possession of powerful jaws, but also in the temperament to use them. This is the object and fulfilment of their existence, for they live and they die as warriors. Thus they differ from their brethren, who, after doing their share of the ' family chores', eventually become mature winged insects and fly away to found new colonies.

The young of the pre-social ancestor must have been able to fend for themselves from the moment of hatching from the egg, as are the cockroaches of today, but already in this relatively primitive society they are fully dependent for food on the older members of the family and without them would starve. This is approximately the state in which the Kalotermitidae, often called drywood termites, exist now—a link from the past with the succeeding elaborated forms. Ancient they may be, but there is no doubt about their ability to cope with the modern world. Just ask the opinion of anyone whose house and furniture is infested with *Cryptotermes*.

Living as they do, in dead wood, just chewing along without a real nest centre or headquarters, the Kalotermitidae might be considered as the ' nomadic cave men ' of the termite world. It is a far cry from them to the centralised and advanced groups which have sprung up independently in various parts of the world. Take, for instance, the Macrotermitinae of Africa and Asia, whose larger members of *Macrotermes* and *Odontotermes* build earth mounds familiar to most people who know those continents.

A caste system

An important step is their acquisition of a worker caste, whose members perform all the labours of excavation, building, food gathering and care of

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It is apparent that the law of diminishing returns is beginning to operate, making it increasingly more difficult to consolidate the rapid advances now being made in these important fields of science. Otherwise expressed, the larger the attendance, the greater the number of participating countries and the more the subject expands, then the less is the value of the conference to the individual participant.

The lessons of these conferences are (1) the efficient administration of the conference is just as important as the arrangement of the scientific programme; (2) the proceedings should be held under one roof, and if decentralising is unavoidable the sections should at least meet in the same building; (3) the scope of these conferences needs to be much more restricted—the possibility needs to be considered whether the main branches of these expanding sciences should not be dealt with in turn on a four-year rotation rather than all together in the same year. The possibility should also be examined as to whether papers could not be grouped and summarised, and the summary read in three languages by selected speakers.

Lecturers dealing with a highly technical subject have a duty to their audience: they should speak slowly, in short sentences and with frequent pauses to allow the broadcasting interpreters and a very mixed audience time to translate and absorb the ideas. They should forget their personal prestige and not try to pack too much into a single paper. A single idea put over in colloquial language and relieved by slides can be much more successful than a highly involved paper of considerable length which has to be read at speed because of restrictions of time.

Indeed, the most important function of these conferences is to bring people together to discuss their business and their work with the representatives of many nations. Those having only a rusty or a colloquial knowledge of another language are, of course, reluctant to engage in a highly technical conversation, and this adds to the natural reserve and instinctive shyness between nations. This can be broken down by engaging technical interpreters from the libraries of large commercial undertakings, such as Verkaufsgemeinschaft Deutscher Kaliwerke G.m.b.H., of Hanover, and by calling on the lecturers to help by providing summaries of their papers in several languages and by all the participants wearing small coloured brooch-buttons to indicate languages with which they are conversant, *e.g.* German, Arabic and Hindustani; German, French and English, and so on.

A world language

WE WOULD suggest that with the rapid advance of science and technology there is an urgent need for an international language to be taught in every school in the world in order to destroy the language barrier and so ensure steady progress in all countries. *The gap between the more advanced countries and the poorer countries is widening and the language barrier is largely responsible.*

This is a subject which has been studiously avoided by the United Nations, but sooner or later it will have to be tackled. The problem is urgent because it will obviously take ten years before it can even begin to take effect, but a start must be made if the story of Babel is not to be repeated in our time.

International recognition for a single world language will mean that fewer languages need be learned and the change-over will be no more impossible than the proposed change from the inch to the metric system. It is advised that during the period of general education, only the mother tongue and the world language should be taught. Subsequently, those selected for a classical education could learn other languages, while those selected for training in science or technology should continue only to use the world language, which might be English, Esperanto or some relatively simple language, such as Malay, to which scientific terms could be added.

THE TERMITE

Part I.—A Social Insect

W. WILKINSON
(*Termite Research Unit, Port Harcourt, Nigeria*)

Termites live in many different types of dwellings and have a family life and a caste system of their own. Part II will deal with the damage caused by these insects.

The mushroom mound of a humus-feeding, forest-dwelling species of Cubitermes—*near Benin, Nigeria*

TO those who make a study of insects the word ' termite ' has a precise significance, as the common name of one of the score or so of orders into which the class Insecta is divided. Far more widely recognised, particularly among those who live in the tropics, will be the term ' white ant '. Nevertheless, there are many termites which are not granted the distinction of being a white ant and, conversely, some pests which are often called white ants are undoubtedly not termites.

It is not only this looseness of definition which leads entomologists to avoid the expression ' white ant ', but also the implication of a relationship to the true ant. In point of fact, the two are no more nearly related than are kangaroos and men. The termites' nearest living kin are the cockroaches, and the precursor of both these ancient branches of the animal kingdom was probably in existence when the coal measures were laid down. Beside them the ants are comparative newcomers, and man himself a rank upstart. The misleading name doubtless originated because of the development in both ants and termites of highly integrated societies, and because of the thin, pallid skin of many of the latter group.

The family unit

Although these societies—known as ' colonies '—are often very complex in organisation and behaviour, the course through which they must have evolved is fairly apparent. The first stage would be a tendency for the parental pair to remain with their eggs and brood. This phase is not uncommon among insects today. For instance, certain earwigs may be found in family groups for no very obvious reason. The process of elaboration from this simple social beginning would be gradual and continuous and doubtless included forms which failed to establish themselves.

Soldiers and workers

Following the gregarious habit, the early termites attained a condition where no doubt exists as to the benefit derived from such a life. A proportion of individuals have become specialised for the defence of the colony, being adapted not only in the possession of powerful jaws, but also in the temperament to use them. This is the object and fulfilment of their existence, for they live and they die as warriors. Thus they differ from their brethren, who, after doing their share of the ' family chores', eventually become mature winged insects and fly away to found new colonies.

The young of the pre-social ancestor must have been able to fend for themselves from the moment of hatching from the egg, as are the cockroaches of today, but already in this relatively primitive society they are fully dependent for food on the older members of the family and without them would starve. This is approximately the state in which the Kalotermitidae, often called drywood termites, exist now—a link from the past with the succeeding elaborated forms. Ancient they may be, but there is no doubt about their ability to cope with the modern world. Just ask the opinion of anyone whose house and furniture is infested with *Cryptotermes*.

Living as they do, in dead wood, just chewing along without a real nest centre or headquarters, the Kalotermitidae might be considered as the ' nomadic cave men ' of the termite world. It is a far cry from them to the centralised and advanced groups which have sprung up independently in various parts of the world. Take, for instance, the Macrotermitinae of Africa and Asia, whose larger members of *Macrotermes* and *Odontotermes* build earth mounds familiar to most people who know those continents.

A caste system

An important step is their acquisition of a worker caste, whose members perform all the labours of excavation, building, food gathering and care of

The characteristic mound and the chevron runways of a species of Procubitermes *in Nigeria*

the young. Like the soldiers, these have no prospect of attaining the status of a normal adult. There is marked progress in occupational specialisation and interdependence, which has reached the point that no caste can survive for long by itself. So, in one sense, the community can be looked upon as a single being, with different castes performing the functions of feeding, defence and reproduction instead of different organs.

The female of the pair founding the colony, known as the Queen (her consort remains beside her for life) is incarcerated in a central chamber of earth and becomes a mere egg-laying machine. Over the years the ovaries enlarge to such an extent that her abdomen is distended to many times its original size. There she lies, a pulsating white sausage, quite helpless as her legs and head no longer touch the floor. The workers assiduously feed and groom her and remove the eggs to the nurseries as soon as they are laid, which has been found in some to be at the rate of one every two seconds. (Poultry are far behind the termites when it comes to intensive egg production.) There is thus an enormous population potential, so it is hardly surprising that estimates of the numbers in a colony range between hundreds of thousands and several millions.

To summarise, there will be found in a nest of *Macrotermes* the King and Queen, parents of the entire colony; soldiers of two distinct sizes; workers in profusion; and eggs.

Mass migration

Dependent on the time of year, winged reproductives may also be present, only waiting for suitable weather conditions to fly off and found colonies of their own. For the new pairs it is important that the ground should be soft enough for burrowing. Thus, after a showery afternoon at the beginning of the rainy season, countless thousands will emerge from their nests. Attracted by lights, they may descend on houses in such numbers as to cause confusion. After a comparatively short flight the wings of these ' flying ants ' are cast off, being broken at a line of weakness near the base. The termites then turn their attention to finding a mate, and subsequently a nesting site. At the same time another pair of organs complete their short-lived function, for the eyes, used only for the little time the insect is in the outside world, will be of no value during the rest of its life, which is spent in total darkness.

Food production

The method of feeding has also become more complex in the Macrotermitinae and gives them the common name of ' fungus growers '. The degree to which these termites can digest pure wood is uncertain. Much of it is formed into a paste and from this are built sponge-like masses in which the total surface area of the multiple internal chambers is very great. On this a fungus, kept well in control, produces tiny white globular bodies and upon these the young of all castes feed. It is likely that, in addition, the material forms an important part of the diet of the worker.

The ' fungus garden ' is also believed to serve an additional purpose by acting as a humidity buffer, absorbing excess moisture in the nest, or supplying it should the level fall too low. As the internal temperature of the nest is also constant, there thus exists an efficient air-conditioning system.

Adaptability

Such an existence as a well-defended colony, often capable of creating and maintaining its own microclimate, is a distinct advantage in colonising new territories and in riding out temporarily unfavourable conditions.

Though reaching their zenith in hot regions, termites are found to a lesser extent in some temperate countries, even where winters may be severe. Western North America and the lower Himalayas are the natural homes of related species which occupy rotten tree stumps. Buildings in Hamburg

and other European towns suffer from the depredations of a temperate zone *Reticulitermes*, originating in North America. In the tropics, with the exception of land over 10,000 ft., almost every terrain from nearly barren desert to mangrove swamp supplies a niche for some termite.

Their dwellings

To avoid desiccation in arid zones they may nest well underground. The outer part of a mound is frequently deserted at the time of day when the sun falls on it most strongly. A great many consist of a diffuse underground system which it is not possible here to describe more fully.

Other subterranean abodes are much more compact and regular, such as the precise and symmetrical structure made by some *Apicotermes*. The pattern of these may be of more use in identifying a species than the rather variable insects themselves. The shape of mounds on the surface is not always to be relied on as an indication of what lies within, for they are liable to be modified according to soil and climatic conditions. For instance, *Macrotermes bellicosus* will build a very tall, thin spire of a mound in arid Somaliland, whereas in southerly areas of heavier rainfall it is to be found in low, wide humps. Quite different again are the 'mushroom mounds' built by *Cubitermes* and its allies, chiefly in forest areas. Some consist of a squat or slender column, topped by one or more umbrella-like caps, whilst certain near relatives are content with a stack of similar caps built in lean-to fashion against a tree.

There is doubt as to the function of these adornments, for some claim them to be rain-shedding devices, and others say they give protection against the sun. There may be some truth in each, but, whatever the advantage, it is also true that other termites of the same group are equally successful in the same localities without any such cover to their mounds[8].

Lodgers

The maze of small, inter-connected chambers within a mound are an ideal opportunity for uninvited lodgers to move in. A number of these invaders are capable of building their own mounds and may help in building their hosts'. The majority, however, have lost this faculty and may use the empty compartments as they are, or modify them. As many as seven species have been found occupying one mound, but their galleries never meet and fighting ensues should they be mixed. The soldiers of some of the smaller squatters are of little apparent use, being weak and with jaws unsuited for biting. *Anoplotermes* engages successfully in the battle for survival without a soldier caste at all. It is often aided, like some other partially demilitarised genera, by very secretive habits.

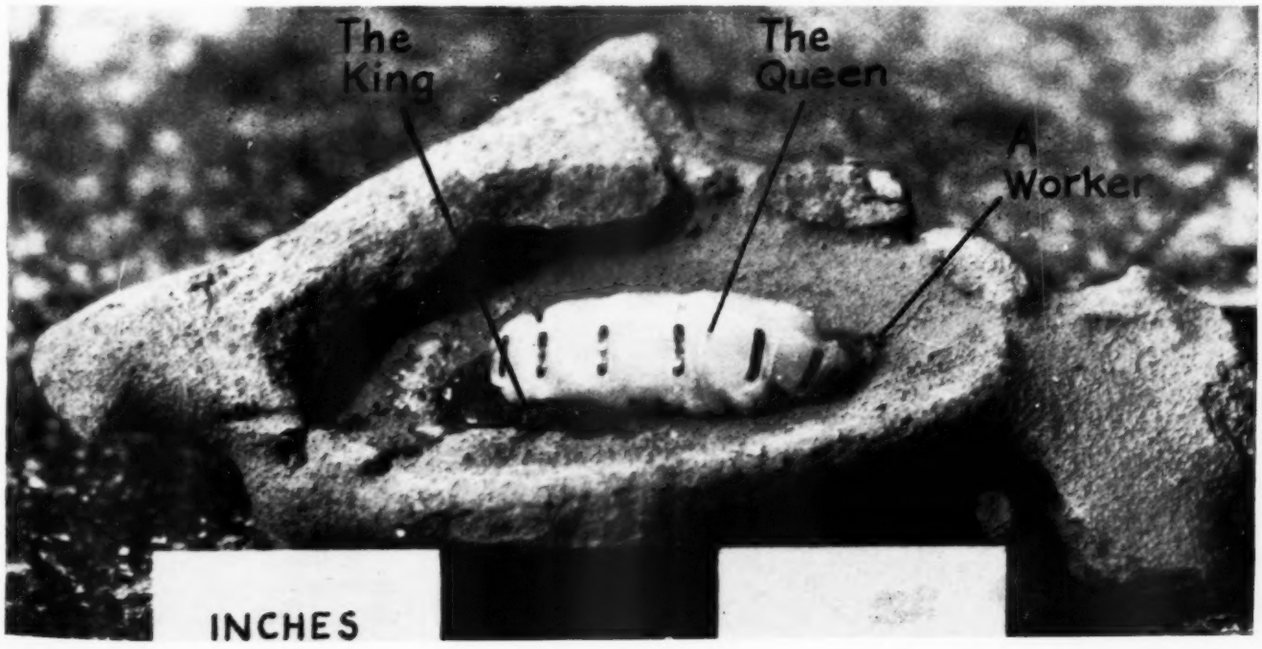
Accent on defence

One of the more obvious aspects of the termite character is its accent on defence. The harvester species may have thick-skinned brown bodies and forage in the open in broad daylight. With this exception almost all their activities are carried out in complete obscurity. They forage in enormous numbers in the ground and above this level are concealed either inside wood, or in hard mounds of earth or chewed wood, or in well-walled nests in the trees themselves. Movements over the surface of an object are made under cover of roofed runways built of earth or carton, and some species commonly attack wood from the outside, protected by a thin sheet of soil.

Consideration of this cryptic habit leads one to ask about the natural enemies of termites. The chief one is doubtless the ant, a more agile insect, using a paralysing fluid in conjunction with its bite, and sometimes having a sting in addition. Without their defensive walls most termites are no match for the ant.

The Nasutitermitinae may be considered an exception on account of

(*continued on page* 446)



The opened royal cell of Macrotermes nigeriensis, *showing a young Queen, perhaps three years old, with her consort and a worker termite*

PENETRATION OF INSECTICIDAL SMOKES INTO MODEL NESTS

W. A. TAYLOR and G. M. S. DUFF

(Research Department, Nobel Division, Imperial Chemical Industries Ltd.)

The control of ants is a serious problem in all tropical and sub-tropical regions. In this paper the mechanism of smoke penetration into the nests of leaf-eating ants, which are a serious pest in South America, is discussed.

THE damage caused by leaf-cutting ants to agriculture in tropical and sub-tropical America constitutes a serious threat to the economies of the areas concerned. The advent of a simple and effective method of treatment would be of considerable importance. To this end some experiments[1] have been carried out using insecticidal smokes in model nests in order to evolve the most effective type of generator and to estimate the prospects for the method.

Smokes from burning mixtures, *e.g.* sulphur/arsenic, have been widely used for the eradication of nests and some success against small nests has been attributed to smoke generators containing benzene hexachloride or BHC. Results using the latter generators against large nests have been variable. Trials have been carried out in Trinidad using BHC, nitrogen dioxide and parathion smoke generators. Results showed that inadequate control of ants was obtained in the medium- to large-size nests which were treated.

Coaton[2] in South Africa found that good control of subterranean termite nests was obtained with BHC and DDT smokes provided complete penetration was effected. *The termites tended to seal off untreated portions of the nests from the treated parts.*

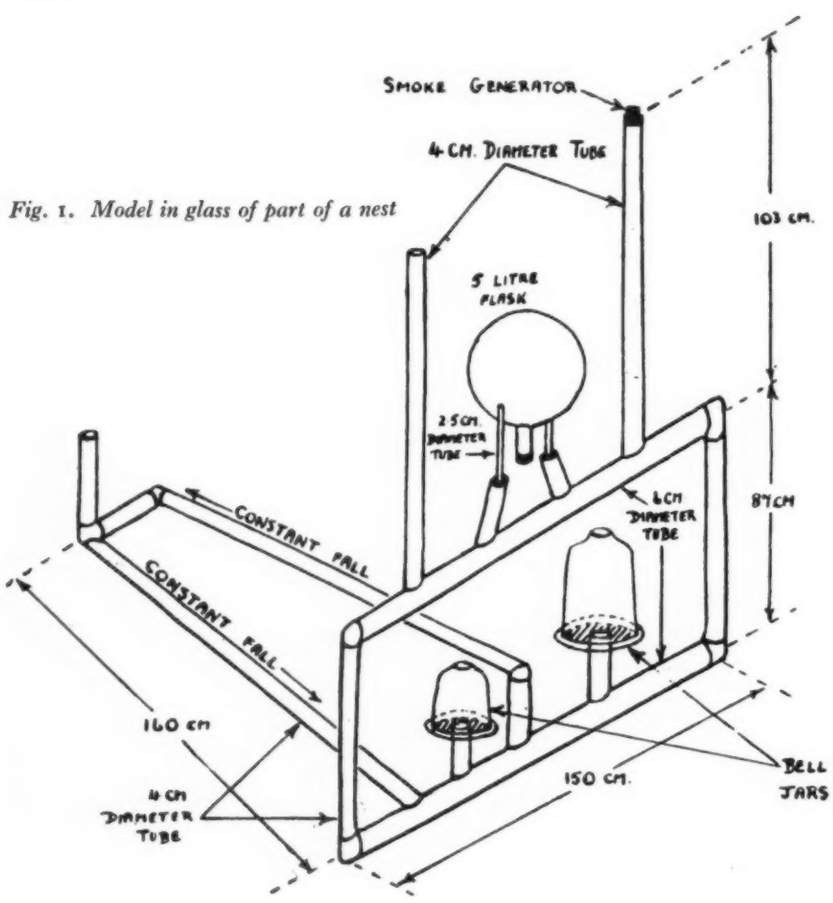


Fig. 1. Model in glass of part of a nest

A model nest

A glass model of part of a typical nest was constructed, as is shown in Fig. 1, based on the descriptions of various investigators.[3, 4] Fungus gardens were represented by a flask and two glass jars. The flask had no outlet to the atmosphere, but the two jars had a slight leakage and may have represented more closely the conditions actually existing in a nest. The size of the model was restricted by laboratory space, but on the assumption that the average ants' nest (hereafter referred to as the ' standard nest') covers an area of 40 sq. m., contains 500 l. of air space and about 40 fungus gardens,* the model was approximately one-fourteenth of the average nest.

A few preliminary experiments were carried out in which various types of pesticidal smoke generator were employed. The generators were reacted in turn, as shown in Fig. 1, and the smoke deposit was collected on glass slides placed throughout the nest. It was shown that where smoke was observed the deposits effected at least a 40% kill of a standard test insect.

A simple theoretical treatment showed that *penetration of a smoke would be proportional to the volume and the square of the speed with which it enters the nest.*

The relationship between the volume of smoke introduced into the model nest and the penetration of the nest was established by reacting various weights of a BHC smoke mixture at the top of the model as before and noting the penetration. The results are plotted in Fig. 2 and it is seen that the penetration tends to an upper limit of about 60%, which is the volume of

* Fungus garden: see Editorial Comment, p. 437

the nest outside the fungus gardens. The relationship is not linear, but this is attributed to the effect of gravity.

In order to establish a relationship between penetration and the velocity of a gas stream introduced into the nest, a smoke generator was designed such that a variable proportion of the smoke evolved could be directed into the nest through a narrow aperture and the remainder exhausted through an adjustable valve to the atmosphere. By means of the valve the speed of the gas stream could be varied and by controlling the time during which the smoke flowed into the nest the volume could be maintained constant. *The penetration of the nest was found to bear a relation to the square of the speed as predicted, but the penetration was much less sensitive to speed than to volume.*

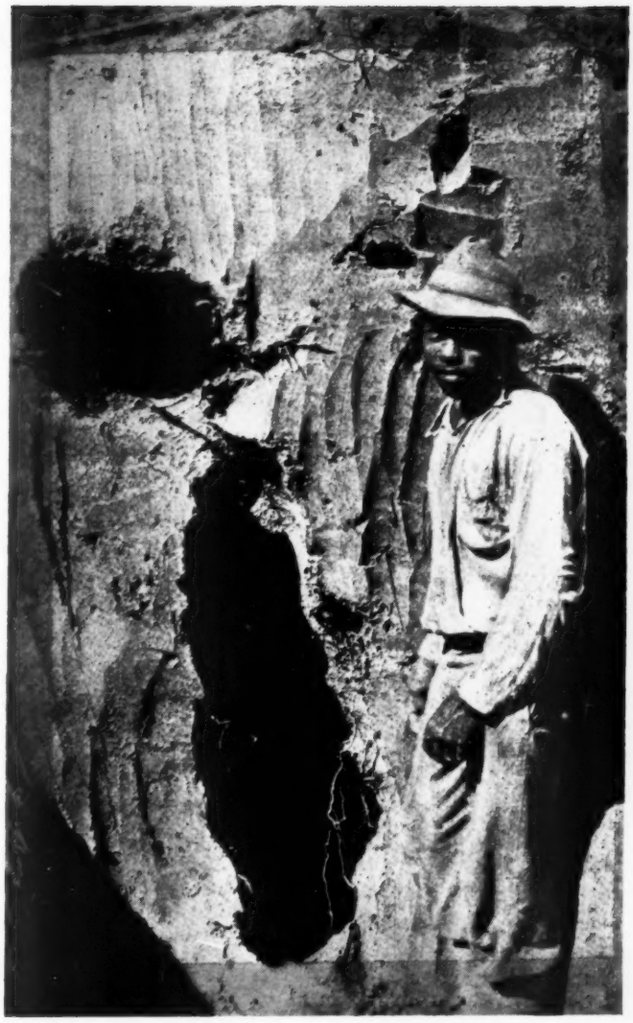
To investigate the effect of increasing the obstruction to the passage of smoke, tests were performed with a number of small-diameter glass tubes inside the main tubes of the nest. By this means it was possible to vary the amount of surface in contact with the smoke and also to vary the complexity of the path. It was shown that the penetration decreases quite rapidly as the complexity of the path is increased.

Other factors which might affect the penetration of a smoke into a nest are:

(*a*) the earth lining in the real nests as against glass lining in the dummy nest, making for greater friction to the movement of smoke;

(*b*) ventilation systems in the nests which may assist or hinder penetration, depending on the position of the generator;

(*c*) higher relative humidity to be expected in nests, which might cause more rapid deposition of the pesticide.



Section through the nest of a leaf-eating ant

An earth tunnel

In order to investigate the validity of the results obtained with the glass model nest as applied to a nest in the ground, a tunnel was dug in soil with access to the open air, as shown in Fig. 3. The tunnel simulated a main passage in a ' standard nest ' and was roofed with short lengths of wire gauze with loose soil on top; this arrangement ensured that a rough surface was presented to passing smoke and, at the same time, the gauze could easily be lifted for inspection.

A series of tests was carried out in the tunnel with pellets of different weights of fast-reacting BHC smoke mixture. The flasks were not connected to the tunnel for these tests. The pellets were set off against the direction of the wind, which was slight. It was found that the penetration of the tunnel was roughly proportional to the weight of composition or

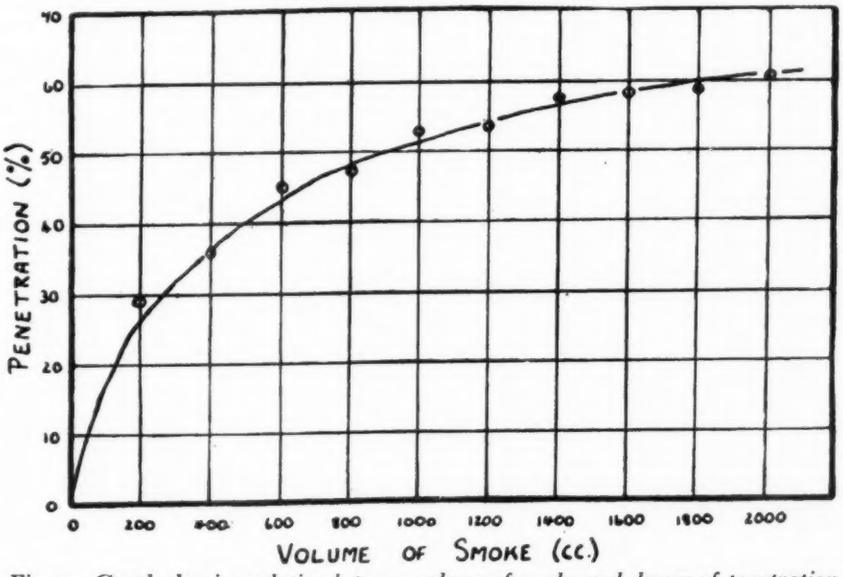


Fig. 2. Graph showing relation between volume of smoke and degree of penetration

the volume of smoke employed. It was seen that a 10-g. pellet would be expected to penetrate completely a passage 7 m. long even without assistance from gravity.

The flasks were then placed in position on top of the tunnel, as shown in Fig. 3. With a fresh wind prevailing, 10-g. pellets of the above composition were set off in turn at both ends of the tunnel. The smoke in the tunnel was turbulent and some smoke was seen to penetrate into both flasks C and D, although the penetration into flask D with the wider entrance was more effective. In stiller air conditions, the smoke crept along the bottom of the passages and none penetrated into the flasks.

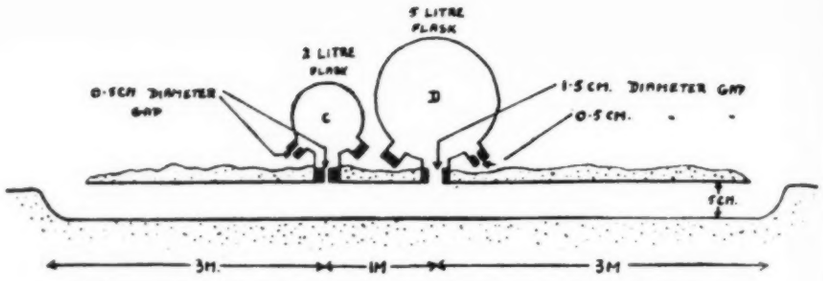


Fig. 3. Model in soil of tunnel leading to two fungus gardens in glass

Discussion

It has been shown that the larger the volume of smoke the greater will be the penetration into an ants' nest. For a 'standard nest' of 40 sq. m. surface area, it has been shown that the smoke from a fast-reacting BHC smoke mixture pellet of 10 g. weight should completely traverse the nest. Even if one of these generators was required to penetrate into two passages simultaneously, a penetration of 3–4 m. should be obtained and the centre of the nest area reached.

Increase in pressure of the smoke jet favours penetration, but to a lesser extent than increase in volume. It may be necessary to rely on as great a volume of smoke as possible, as it would be difficult to produce a biologically efficient smoke mixture with a very high reaction rate.

Work on both the earth and glass models has shown that, unless there is turbulence in the smoke, no penetration into the fungus garden is likely. In still air conditions in both models the smoke was seen to creep along the bottom of the passages. If a pesticide with a high vapour pressure were employed, there would probably be some diffusion into the fungus gardens. If such a pesticide was not available, it would be necessary to rely on the smoke penetrating the main passages only and in such circumstances a pesticide which is non-repellent to ants would be required or the ants would be likely to seal off the contaminated portion of the nest. As previously noted, this behaviour has been observed in termite nests.[2]

It was noticed in both models that the BHC was rapidly filtered out of the smoke on to the tunnel walls and for this reason as pure a grade of pesticide as possible would be preferable so that the lightest deposit would be effective.

In conclusion, it is thought that the smoke technique, coupled with a suitable pesticide, would be a convenient and effective method of controlling nests of leaf-cutting ants.

This work was carried out in Scotland in the Research Department of the Nobel Division of Imperial Chemical Industries Ltd.

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2. Coaton, W. G. H.: 'Farming in South Africa', 1947, September, 1.
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4. Jacoby, M.: *Z. angew. Ent.*, 1952, **34**, 145.

Insect Species Used for the Biological Control of Noxious Weeds

(*see opposite page*)

1. Lepidoptera:
   Thecla echion L.
   Thecla bazochi Godman.
   Epinotia lantana Busck.
   Platyptilia pusillidactyla Walker.
   Cremastobombycia lantanella Busck.
   Diptera:
   Eutreta xanthochaeta Aldrich.
   Agromyza lantanae Froggatt.
   Hemiptera:
   Teleonemia scrupulosa Stål.
2. Lepidoptera:
   (4) *Blepharomastix acutangulalis* Snellen.
   (4) *Diastema tigris* Guenée.
   (4) *Catabena esula* Druce.
   (4) *Syngamia haemorrhoidalis* Guenée.
   Coleoptera:
   Octotoma scabripennis Guerin.
   Hemiptera:
   Teleonemia vanduzeei Drake.
3. Coleoptera:
   Aerenicopsis championi Bates.
4. Lepidoptera:
   Catabena esula
   Diastema tigris
   Syngamia haemorrhoidalis
   Blepharomastix acutangulalis
5. Lepidoptera:
   Bactra truculenta Meyrick.
   Coleoptera:
   Athesapeuta cyperi Marshall.
6. Diptera:
   Procecidochares utilis Stone.
7. Lepidoptera:
   Melitara prodenialis Walker.
   Cactoblastis cactorum Berg.
   Melitara bollii Zeller.
   Coleoptera:
   Lagocheirus funestus Thomson.
   Moneilema armata LeConte.
   Homoptera:
   Dactylopius opuntiae Cockerell.
8. Thysanoptera:
   Liothrips urichi Karny.
9. Lepidoptera:
   Episimus sp., probably *stringulana* Walker.
10. Coleoptera:
    Apion ulicis Forster.

The Termite

(*continued from page* 443)

their unusual soldier caste. The atrophied jaws are virtually useless, but superseding them is an effective organ of chemical warfare. From the tip of the pear-shaped head can be squirted a sticky, corrosive fluid of objectionable odour. Small ants hit by the semi-solid filament are quickly tied up in knots and the rest of the attackers show a loss of enthusiasm.

In certain countries mammals, such as the aardvark and the various anteaters, dig into nests and take their toll, but otherwise the termites are not seriously molested. The swarms of unprotected flying reproductives are in a quite different position, however, and their mortality rate is extremely high. Birds, lizards and frogs feast royally and the majority of those which escape from the larger predators are hounded down and dug out by ants.

THE BIOLOGICAL CONTROL OF NOXIOUS PLANT SPECIES IN HAWAII

ALAN THISTLE

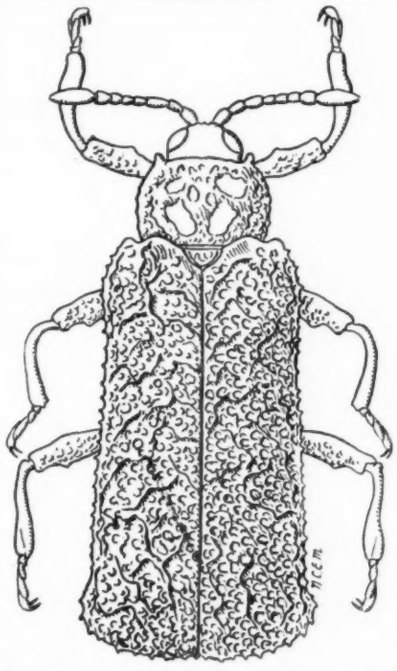
(*Division Director, Board of Commissioners of Agriculture and Forestry, Territory of Hawaii*)

DUE to the comparative paucity of insect genera existing in the Hawaiian Islands, singular success has been obtained in the suppression of exotic pests—both plant and animal—through the introduction of the pests' natural enemies.

The control of exotic insect pests through the introduction and establishment of their natural enemies is a comparatively old technique, but the suppression of noxious plant life by this method is of fairly recent origin. The principles are much the same, but the risks involved in the introduction of insects or diseases that attack plant life are far greater than the introduction of insects or diseases that attack insects.

In our present work, potentially promising insect species are subjected to exhaustive feeding and other tests in order to make certain that they will not attack desirable plants or become otherwise objectionable.

The suppression of noxious plant life, such as Gorse, Lantana, Nut Grass, Firebush and Christmas Berry, by means of insects may be a new idea to some of our readers.



Octotoma scabripennis *Guerin, one of the insects introduced into Hawaii for the control of* Lantana camara

Lantana

Lantana camara, Verbenacea

The first recorded attempt by man to control a plant pest biologically was undertaken in Hawaii in 1902. The plant was *Lantana camara*, which had been introduced as an ornamental plant in 1858. The shrub caused no difficulty until some years later, when the Chinese turtle dove was introduced. The birds fed on the juicy fruits, spreading the seed far and wide in their droppings. By 1900 hundreds of thousands of acres were infested by this vigorous, thorny shrub. The ranchers themselves were spreading a scale insect, *Orthezia insignis*, which has a wide range of host plants, in an attempt to control the pest. This practice, while it was discouraged by the agricultural authorities, may have given them the idea of introducing something more specific for its suppression. In any event, Professor Albert Koebele, Territorial Entomologist, went to Mexico, the native habitat of *Lantana*, to study its natural enemies and a British entomologist, Dr. R. C. L. Perkins, was stationed in Hawaii to receive, breed, rear and release any insect species sent by the Professor.

On the first attempt to control Lantana they concentrated on insect enemies of the flowers and fruit in the hope of stopping the rapid spread of the pest and they were singularly successful. Of the 23 insect species shipped to Hawaii by Professor Koebele, eight[1] became established and the rapid spread of Lantana over uninfested lands came to an abrupt halt. The successful establishment of any species was indeed remarkable considering the distances involved and the slowness of transportation in 1902. None of these was found to attack desirable plant species.

No further work was attempted on *Lantana camara* until 1951, when Hawaii solicited the co-operation of other tropical countries with a Lantana problem in a joint scheme to search for and introduce enemies which would attack the leaves, branches, stems and roots of the pest.

The State of Queensland, Australia, the Federal Government of Australia, the Crown Colony of Fiji and the Trust Territory of the Pacific Islands, together with Hawaii, became parties to this scheme. The Australian entomologist, John Mann, and the Hawaiian entomologist, Noel. L. H. Krauss, were sent to Mexico and other countries in tropical America to search for and ship to Hawaii colonies of insect species found attacking Lantana. Hawaiian entomologist Q. C. Chock received the shipments for propagation and testing under elaborate quarantine conditions in Hawaii. Over five thousand Lantana plants and numerous economic and ornamental species were established in pots for the breeding, rearing and testing work. Six[2] leaf-feeding insect species and one[3] branch- and stem-boring species have been tested and approved for release in Hawaii and Fiji. Other insect species which attack the plant in various ways are still under study.

At the time of this writing the Australian entomologist, K. L. S. Harley, is further testing four[4] of the leaf feeders on additional plant species of economic importance to Australia.

It is too early to evaluate the control these new introductions will have on the existing stands of Lantana, but the branch, stem and root borers appear particularly promising.

Nut grass

Cyperus rotundus, Cyperaceae

Because of the outstanding success in stopping the spread of Lantana, the

sugar and pineapple industries requested the introduction of insect enemies of Nut Grass, *Cyperus rotundus*, a vigorous sedge which is primarily a pest of cultivated lands. In 1925 Hawaiian entomologist, Fred Muir, shipped two[5] species of insects from the Philippine Islands, which became established. They are of little importance, however, in the control of this pest.

At this point it might be well to state that the biological control method does not appear to be suitable for the control of weeds on cultivated land where clean culture is desirable.

Maui Pamakani

Eupatorium adenophorum, Compositae

This tropical American shrub was purposely introduced to Hawaii about 1900, presumably for medicinal purposes. Within a few years it had rendered many thousands of acres of excellent grazing land worthless. The plant has no forage value and forms dense thickets about 10 ft. high in areas suitable for its growth.

In 1944 Hawaiian entomological explorer, Mr. Noel L. H. Krauss, following previous ecological studies of this plant by others in Mexico, shipped live colonies of a stem-galling fly[6] to Hawaii for testing with respect to host range. The insect was determined specific to the pest and was released from quarantine for field establishment. The female fly oviposits her eggs in the tender terminals of the plant, where the developing maggots cause a sizable swelling or gall. Numerous galls may be formed on a single plant, inhibiting flowering and in many instances causing death of the plant.

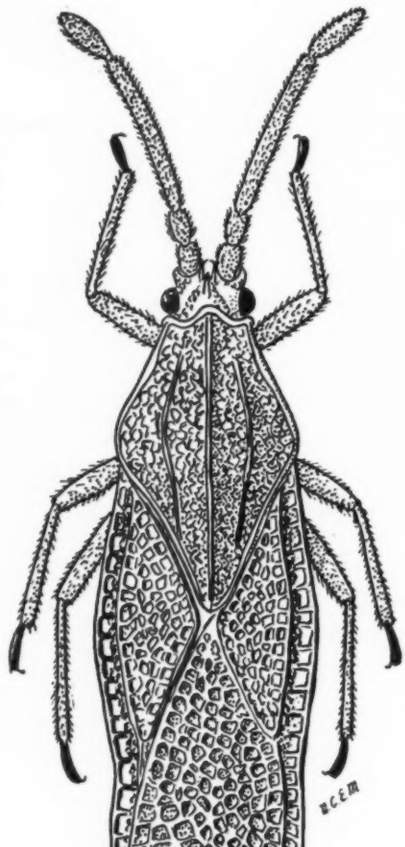
Within a few years the fly population had increased to such an extent that thousands of acres, which had been covered by an impenetrable thicket of this noxious plant, were converted to productive pasture land.

Panini

Opuntia megacantha, Cactaceae

This tropical American member of the cactus family was purposely introduced about 1809. By 1900 it was observed to be spreading out of its natural, lowland, arid habitat to the better upland pastures. As the species became acclimatised, it formed solid, almost impenetrable, stands over thousands of acres.

Fortunately, Hawaii was able to rely on the excellent work of Australian entomologist Alan P. Dodd, who had previously studied the enemies of a related species of *Opuntia* in tropical America. Mr. Dodd is considered primarily responsible for the introduction



Teleonemia scrupulosa *Stål, one of the insects introduced from Mexico for the control of* Lantana camara

to Australia of cactus enemies which cleared approximately 60 million acres of cactus-infested rangeland. Through the assistance of Mr. Dodd and others, colonies of a number of insect species were obtained and tested against the Hawaiian cactus species. Six[7] were found to attack the plant and were determined safe for liberation. Consequently, in 1949 and 1950 colonies of the six species were released for field establishment.

By 1955 the mealybug had practically eradicated the cactus in all arid range country where it had been released. One of the moth species was accomplishing spectacular work on the cactus at higher elevations. One of the beetle species was well established in the moist regions, but because of slower multiplication its effectiveness will not be so noticeable for a few more years. The other species have not been recovered and may not be established.

Clidemia

Clidemia hirta, Melastomaceae

This potentially serious plant pest was discovered in a forest reserve area in 1952. While the plant could not be considered as objectionable in the forest reserve, its record as a noxious pest of rangeland in Fiji, where it is called 'Köster's Curse', was well known.

Here, again, Hawaii was fortunate in being able to take advantage of previous work by another country. Fijian entomologist, H. W. Simmonds, had made ecological studies of the plant in Trinidad, B.W.I., and had introduced to Fiji a thrips[8] which attacks the terminal growth. Colonies of this insect were obtained through the courtesy of the Fijian authorities and, after testing, the insect was released for field colonisation. The insect does such excellent work in stopping flower and fruit production that the danger of Clidemia becoming a rangeland pest in Hawaii is probably permanently removed.

Christmas berry

Wilelaiki Schinus terebinthifolius, Anacardiaceae

This shrub or small tree was introduced to Hawaii as an ornamental from Brazil. A number of species of introduced birds feed on the fruit and scatter the seed over the countryside in their droppings. In a suitable habitat, the plants form a dense canopy over the land, permitting no other plant life to grow. Many thousands of acres of potential grazing land is thus rendered worthless.

In 1953 Krauss was sent to Brazil to study the ecology of the plant in its native home. Three insect species found attacking the plant were considered of importance and colonies were shipped to Hawaii for testing. Subsequently, one[9] of these was released for field establishment and is currently doing good work in certain areas.

Firebush

Myrica faya, Myricaceae

This tree is a native of the Azores

and Canary Islands and was introduced in 1900 by Portuguese immigrants. Birds feed on the juicy fruits and the plant is spread in this manner. For some years it was also purposely spread by foresters in the establishment of watersheds and forest reserves. Unfortunately, the plant did not confine itself to these areas and considerable mechanical and/or chemical control is now required to keep the pest from overrunning grazing lands.

In 1955 Krauss discovered a species of moths attacking *Myrica cerifera* in Florida and Georgia, U.S.A. Colonies were despatched to Hawaii and the caterpillars were found to attack *M. faya* also. Host range tests proved that the moths would not attack any plant species of economic importance, so in June 1956 the moths were released for field establishment.

Gorse

Ulex europaeus, Leguminosae

This serious pest of rangeland was purposely introduced to Hawaii for use as a living fence on sheep ranges. Unfortunately, the plant was introduced without any of the natural enemies which apparently keep it confined to hedgerows in its native habitat. It has now spread into solid stands over a considerable area.

Colonies of a seed-destroying weevil[10] obtained from New Zealand became established in 1949, but it is not effective at present in stopping the spread of gorse in Hawaii. The weevil was originally obtained by New Zealand entomologists in England. In 1955 and 1956 U.S. Department of Agriculture entomologist, H. Parker, shipped colonies of the same species of weevil which he had collected in the south of France. There has been a rapid increase in these weevil populations and it is therefore surmised that the French strain is better suited to Hawaii's conditions than the English strain (via New Zealand).

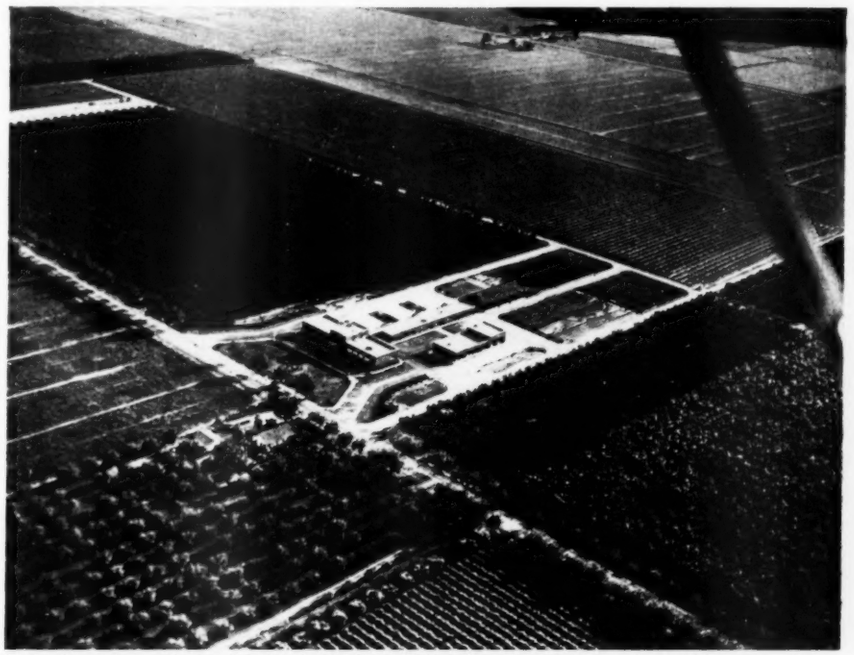
There are a number of other plant pests in Hawaii which are now being studied with a view to their biological control. The number of species that can be worked on at any one time is limited by the funds provided, the availability of special buildings required for quarantine testing and lack of trained personnel.

Drawings by N. C. E. Miller, Commonwealth Institute of Entomology.

For references, see page 446.

Oil Aids Agriculture

Crop Protection by Petroleum Products



U.S.A.—view of the Shell Agricultural Station at Modesto in California, where pesticides, fungicides, weedkillers and hormones derived from petroleum are tested

THE world is never really free from the threat of famine. Its surface may be scorched by droughts or inundated by floods; plant pests and diseases and plagues of devouring insects each year consume one-third of Man's crops; and even in good climatic conditions high productivity can only be achieved with the aid of science.

In many areas the people either exist on bare subsistence rations scratched from dusty ground or on imports of food from productive regions. The transport and distribution of food from prolific to barren areas is largely a political and economic problem, but the task of producing this food depends on the farmers. Farmers, however, need more than land, implements and seeds—they need also the advice and experience which can only be provided by specialists constantly studying the difficulties in producing food in all parts of the world.

One of the latest and most effective weapons of the scientist is oil, and the oil industry is now actively intensifying research into land problems in various overseas territories. The field for research is vast and the range of farm products under review is prodigious: they may be different types of oils for machinery, or valuable chemical substances, scarcely recognisable when transformed into weedkillers or nitrogenous fertilisers.

France.—A derelict and rambling farm in the Yonne department of France was selected in 1950 by the Service Agricole Division of Shell Française to demonstrate to French agriculturists and farmers what can be done by modern methods to improve the yield on the average farm holding. Investigations are also in progress at this station into the habits of potato bugs and fruit tree parasites, and into the cultivation of cereal crops and grasses.

Italy.—From a single farm to a whole settlement: this is the scope of the work at Borgo a Mozzano, in Northern Italy. This commune of 8,000 inhabitants comprises three zones—a mountain zone, then one that is predominantly hilly, and a third that is mixed hill and plain.

An agricultural technician from Shell Italiana advises the people on land management, mechanical cultivation and fruit growing. He also gives advice on strains of seeds and alternative crops. Attention is being given to restoring the chestnut woods, which once flourished, but have been declining in importance, partly owing

(Above) *Ceylon — view of Tettawela irrigation 'tank' showing heavy infestation with* Salvinia auriculata, *just before spraying*
(Left) *Venezuela — a field officer of the Shell Agricultural Research Station at Caracas inspecting damage done to sugar-cane by a 'Moses' caterpillar*

to pests. They produce timber, flour and nuts.

Venezuela.—Farming on a national scale forms the basis of the non-commercial 'Servicio Shell Para el Agricultor' established in Caracas. Based on a 100-acre farm, equipped with workshops and laboratories, this service works in close collaboration with the Ministry of Agriculture and local farm schools.

This was an innovation in Venezuela, where for many years agriculture has languished, mainly because of a shortage of farm workers, the unresponsive nature of the soil and climatic problems.

Now farming has been reinvigorated by the skill and knowledge of chemists and technicians who demonstrate modern agricultural methods, including the use of farm machinery. Farmers have been shown the most efficient way to grow crops, such as cotton and sugar-cane, including new varieties, and also how to use fertilisers, how to protect crops from insects, fungi and the competition of weeds, how to use irrigation and how to avoid planting crops in unsuitable soils.

U.S.A.—A more ruthless type of farming is carried out at Modesto in California. Here, besides normal farming, crops are often grown to be destroyed on the spot: insects and parasites are deliberately encouraged to ravage plants and infest trees.

Thus the farmer-scientists gain a peculiar pleasure from seeing their crops ruined, for they know they are providing breeding grounds in which to test insect- and pest-killing products. The work follows the routine of an ordinary farm, with the usual cultivation, fertilising, planting and pruning during spring, and irrigation and spraying in summer.

The station includes greenhouses, laboratories and repair shops for servicing farm equipment. A recent addition is a house in which temperature and humidity is automatically controlled for the purposes of carrying out experiments under different climatic conditions.

Ceylon.—The control of aquatic weeds has always been a major problem owing to the expense of mechanical removal and the difficulty of effective treatment by chemicals. *Salvinia*, a particularly obnoxious weed, every bit as serious as water hyacinth, is spread rapidly as a result of the severe flooding of the paddy fields which occurs in certain seasons and it can also be carried for hundreds of miles on the feet of aquatic birds. It is a relatively small weed which is supported on the surface of the water by its bladder-like stalk, but it multiplies very rapidly and soon forms a continuous sheet, often many hundred acres in extent, and even up to a foot in thickness, if the depth of the water is sufficient. It may completely cover the surface of inland lakes, waterways and canals and choke the drains in the paddy fields, thus not only impeding navigation, but also making it impossible to grow rice.

As a result of experiments carried out at the Kudawewa and Tettawela 'tanks' in the N.W. Province of Ceylon, it has been found that this weed can be destroyed by several applications of Shell salvinia weed-killer, but continuous vigilance is thereafter necessary to ensure that no fresh invasions occur.

U.K.—The Shell Agricultural Research Experimental Station at Woodstock, Kent, is a world centre for agricultural research. Problems come here from areas as widely scattered as Ceylon, Kenya or the Philippines and may involve action against pests or diseases found in such important crops as tea, coffee, maize, cocoa or rice, even though none of these is grown in the U.K.

Special apparatus has been installed, including an artificial rainmaker and ultra-violet lighting to offset the short day of the British winter. The research staff is also required to study a variety of insect life foreign to British shores, such as the desert locust, mosquitoes and termites.

INTRODUCING A NEW CROP PROTECTION CHEMICAL

E. HOLMES, M.SC., PH.D., F.R.I.C.
(Technical Director, Plant Protection Ltd.)

ANY technical man responsible for the development of new crop protection chemicals must feel from time to time like a cooper endeavouring to make a cask from staves of assorted sizes. He is endeavouring all the time to keep the staves (representing his various activities) of the same length. On the few rare occasions that he achieves this he probably thinks the phenomenon a miracle.

Following the simile somewhat further, the base of the cask may be considered as the assessment of problems worth tackling and the discovery of chemicals likely to be useful in achieving the solution of these problems. Even at this stage there are a great number of questions— some obvious; some not so obvious. It is relatively easy for any given territory and for any given crop to obtain the acreage affected. It is less easy to determine average yields under various conditions in different localities, and still more difficult to determine the profitability of the crop under these different conditions. Added to that, of course, the development man's prime preoccupation at this stage is to determine how far the particular pest he is considering is doing economic damage to the crop and to try to guess what the grower would be prepared to pay to prevent such damage.

Having first decided on a crop protection problem and found the chemical to deal with it, this is only the beginning. There are many more considerations before a new product can be put on the market.

Evaluation of problems

Quite frequently it is found that, although huge acreages are involved and pests of economic significance are present, there is still no worthwhile problem to tackle. By way of example, it has been suggested that rice in India, Burma, etc. should represent a very large potential market for seed dressings capable of controlling seed-borne diseases. This is true. On the other hand, it has been demonstrated that it would be possible merely by simple selection of seed to obtain increases in yield of the order of 10 to 20%, yet this is not done. If this is appreciated, it is fairly obvious that seed dressings which might give benefits of the order of 5 to 10% in some, but not all, seasons will need a tremendous amount of hard development work, and the results may not justify it.

On the other hand, there are certain money crops grown on appreciably smaller acreages, *e.g.* plantation crops where growers are more enlightened, where a demonstrable improvement in yield as the result of applying crop protection products would be followed fairly quickly by worthwhile sales of those products.

Doubtless many research laboratories have chosen one or more prime targets in the entomological, mycological and weedkiller fields and have found that those that looked the biggest may not be the ones worth tackling for a totally different reason. Not only must there be a worthwhile target, but the research workers must have some idea of how to tackle the particular problem. In some cases fundamental knowledge may be lacking and the chemical work may have to wait for the results of long-term biological investigations.

Problems of development

The present writer has on a previous occasion (WORLD CROPS, 1952, **4**, 10) indicated how a particular company sets about trying to find new chemicals for specific purposes. Briefly, these may be chosen as chemicals available from other work, or by hit and miss methods, or as the result of careful reasoning from earlier work, or from mere hunches. Almost invariably something useful comes out of such work, but, as often as not, the useful new development turns out to be the solution of some parallel problem rather than one under immediate investigation.

Having provided a base for our cask,

Large-scale field trial. Spraying grapefruit trees in Cyprus with parathion to control scale insects. Note the protective clothing

i.e. decided on the problem to be tackled and found a chemical capable of solving that problem, the serious work of erecting the staves of the cask, or taking care of the many development problems, really begins. These may be listed: (1) initial field tests, (2) semi-scale manufacture, (3) formulation, (4) patenting, (5) selecting names, (6) toxicological and other government requirements, (7) large-scale manufacture and (8) large-scale field trial and demonstration.

Testing new crop-protecting chemicals in a glass-house at Fernhurst Research Station

Field trials

The chemical firm involved in these exercises normally carries out its first-stage field trial work in the country of origin. Nevertheless, quite soon it becomes evident that conditions in that country may be appreciably different from conditions in other countries growing the same crops, but which may offer greater potential markets. It then becomes necessary to carry out trials in a whole series of overseas countries. At this stage the requirements in manpower, and therefore money, become serious.

Most companies in this business have gone through the stage of sending out large numbers of working samples to research workers and others in different parts of the world. The general experience is that nothing further is ever heard of at least 60% of the samples; rather unsatisfactory reports may be received of perhaps 30%; and if really worthwhile results are obtained on as much as 5 to 10% one is probably doing very well. This is by no means always the fault of the research worker who originally requested, or accepted the offer of, such samples. His programme is often dependent upon a number of factors outside his immediate control: the crop, the pest or the weather may be unpropitious in the season concerned, or he may not have the right machinery to apply the product.

Such methods are about the only ones open to small concerns, but the bigger companies have come or are coming to the conclusion that the only way to obtain worthwhile results, positive or negative, is to send out teams of their own to each of the countries representing markets justifying such action. The ability to send such teams is normally dependent upon the availability of a fairly large pool of research workers based on some centre in the home market, such workers having had considerable experience in co-operation with growers of all kinds, with agents and, of course, with official research workers. Under these conditions one may hope to lay down a large proportion of the trials originally envisaged and to carry at least half of them through to completion, but again the crop, the pest and the weather have a habit of nullifying a considerable proportion of such efforts, quite apart from accidents which may always occur in the conduct of experiments. Thus in one elaborately designed experiment the over-anxious farmer had, on his own initiative, decided to treat the control plot in which the pest concerned had begun to do serious damage.

Production problems

As soon as these field trials indicate that a new product is showing real promise, the man responsible has to consider ways and means of obtaining larger development quantities: firstly, in order to devise an economic process and determine the plant required for large-scale manufacture; and, secondly, in order to obtain preliminary indications of yields and costs.

This is always a difficult stage and one requiring the availability of large quantities of multi-purpose plant capable of being linked up in a variety of ways for different manufactures. Usually only a large chemical manufacturer has such facilities. If the product is highly toxic, then the complications are much greater.

Patenting

If the new product looks promising after extended field trials, and the development man can see his way to getting it manufactured by a practical route, he has next to consider making sure of his rewards. Usually this takes the form either at this stage, or even earlier, of taking out patents in appropriate countries. Patents may cover entirely new chemicals, their use for crop protection purposes, and formulations of those chemicals devised to give optimum results. If the chemical is in a field that has been worked in by a number of companies, then the chances of getting patent acceptance without interference is unlikely, but the extent of the interference, even of litigation, will depend on circumstances. However, it is another stave of the cask which has to be built up as solidly as possible.

Naming

The question of names was mentioned as representing another stave of our hypothetical cask. This may sound a very trivial matter, but it is surprising how often one or more names which may seem appropriate to the originator runs into trouble in the different trade mark offices of the world. In some countries it is possible to register a name similar to one already in existence, provided the latter is in a totally different class *e.g.*, crop protection product with name 'X' can live alongside

A seed-dressing trial at Fernhurst. Counting ears of wheat to determine the efficiency of the treatment

a patent medicine of name 'X'. In other cases procedure and regulations are different and either one starts again to find a totally different name which is acceptable in all the more important countries or one ends up with a series of names each acceptable in some particular territory.

More recently, of course, the question of coined common names has come into prominence, the desirability of some short characteristic name for use in place of very long systematic chemical names being obvious. In Britain this activity is the function of a committee of the British Standards Institution, although that committee is grateful if companies originating new products can suggest suitable names to meet these requirements. In the U.S.A. the American Standards Association has recently undertaken the same function, but here the originating company, if it sponsors a common name, is expected to contribute the sum of $300 for the privilege of having its own new chemical named in this way and without any guarantee that its proposal will be acceptable.

Toxicity

Having justified a promising chemical by field test, determined the best way of making it as the result of semi-scale manufacture etc., and formulated it to give optimum results, there are still several other staves of our cask to consider. Government departments are becoming more and more aware of their responsibilities to the general public for seeing that new products are (*a*) not unduly hazardous to operators handling them in the field and (*b*) not likely to leave residues in food crops dangerous to the consumer. The most highly organised work on these two aspects is that at present carried out by the U.S. Department of Agriculture and the Food and Drug Administration at Washington, operating under the Miller Act. Any manufacturer who wishes to sell a new chemical in the U.S.A. must produce a tremendous amount of toxicological data, not only for the *per ora* toxicity, but toxicity by skin absorption, by inhalation and so on. Furthermore, one or more years of experimental work are needed to determine what quantities of the chemical, if any, are likely to be left in food crops at harvest time. The tolerances allowed by F.D.A. are not related directly to the actual toxicity of the various chemicals concerned. It is assumed that any chemical residue left in a food crop is undesirable, and the tolerance permitted is little more than can be achieved under field conditions when the product is applied as directed on the label. Such work is becoming more and more onerous and it is being freely stated in the U.S.A. that this aspect of development costs something of the order of $1 million.

Manufacture and demonstration

Assuming that these further requirements have been met, the development officer has finally to consider with other departments of his company the problem of large - scale, economic manufacture and field demonstration, leading ultimately, he hopes, to large and profitable sales.

Probably if one in 30 new compounds which looked interesting in the initial field trials reaches the final stage of manufacture and sale, then the development man can probably feel pretty satisfied. Equally, of course, one cannot blame him if at intervals he feels that he has been trying to construct that hypothetical cask with staves of india - rubber — and that rubber of differing elasticity!

Large-scale manufacture of crop-protecting chemicals. A grinding plant for the production of dispersible powders

CONCENTRATE SPRAYING

G. J. ROSE, B.SC., F.R.E.S.
(*Entomologist, Micron Sprayers Ltd.*)

CONCENTRATE spraying was first considered because it offered a possible solution to a few special problems, such as the control of locusts on rough, dry terrain. Under conditions which coupled an extensive area for treatment with an acute shortage of water, the concentrate spraying technique, implying the application of extremely low volumes of total spray liquid per acre, has gained ready acceptance.

Following the acceptance of the concentrate technique for the solution of such extreme problems, there has been a long period of trial which has resulted in the adoption of the technique to control pests and diseases in a great many of the world's economic crops. A number of important lessons have been learnt during these years of trial.

The testing period for concentrate spraying can now be said to be over and a stage has been reached when farmers can be left to develop the technique under their own conditions.

A lightweight trolley-mounted concentrate sprayer designed for work in closely-spaced rows
(Left) *An aircraft atomiser that has met with great success*

Types of equipment

The 'concentrate' principle has been introduced into four main types of ground spraying equipment. They are the very lightweight shoulder-mounted portable sprayers, the lightweight machines mounted upon a single-wheel trolley, the heavier portable machines requiring two or more men to carry them, and still larger units, suitable for mounting upon a tractor, truck or tractor-hauled trailer. Of these, the very light one-man portable machine, the lightweight single-wheeled trolley mounting and the tractor-mounted units have proved the most satisfactory. The larger trailer units and the heavier portable units have not proved as useful in the field, although for certain operations, such as the application of fungicides to tall tree crops growing in a rough terrain, there is no choice but to accept the heavier portable equipment, since the unit has to be large enough to provide adequate power to project spray to a height of 70 ft. or more.

Improvements in engines

The very light portable concentrate sprayers were for a long time condemned because of the unreliability of their engines, the complexity of their mechanism and their weight; much of this criticism was justified, since in the vast majority of cases the light one-man portable unit has to be operated by men whose mechanical ability from the point of view of maintenance is limited. When the need for such equipment became more obvious because heavier machinery was found to be a great embarrassment in certain conditions of operation, manufacturers paid more and more attention to the task of increasing the reliability and diminishing the weight of the shoulder-mounted machines.

One of the snags of the small 2-stroke engines, incorporated in these machines, is the difficulty of starting them either cold or hot after spray refills; this problem has usually been overcome by improving the carburation and ignition. It is nowadays possible to obtain shoulder-mounted machines, equipped with reliable and easy starting engines, whose working parts have been reduced to only the engine shaft, to which the spraying system is coupled direct.

It is interesting to note that recently a small shoulder-mounted concentrate sprayer has been produced which is capable of emitting 950 cu. ft. of air per minute, although it is only powered by a 34-c.c. 2-stroke engine.

Aerial spraying

The aeroplane fitted with spraying equipment has always been more of a concentrate sprayer than anything else. However, in the past insufficient attention was devoted to the problem of atomisation and effective control could not be gained with the extremely low volumes of spray liquid per acre that are being successfully used today. These successes are to a very large degree due to the fact that the principle of rotary atomisation has been modified to make it suitable for use on aircraft. The ability to obtain pest control with a gallon per acre of spray liquid, or less, has enabled smaller and more manoeuvrable aeroplanes to be used; this has led to the possibility of applying chemicals by air to areas of crops, planted on difficult ground, where previously it was considered that aerial operations were out of the question.

It is hard to make a general statement on the most suitable form of concentrate sprayer, since local conditions will always affect the choice of montage; but it seems likely that in the future by far the greatest amount of concentrate spraying will be carried out either by one-man portable machines (or, whenever possible, single-wheeled lightweight trolley-mounted machines) or by aeroplanes, equipped with really efficient atomising appar-

A tractor-mounted concentrate sprayer working in an apple orchard at night

atus. Whenever ground and planting conditions permit, and where the acreage to be treated would not justify aerial operation, it seems likely that the tractor-mounted unit will always have a place.

Operational hazards

As a result of the long period of development, much has been learnt of the chemical problems involved. A really well-designed atomising system must be able to handle all types of chemical formulation. However, the general economy of the system has often enabled the more expensive liquid formulations with their added efficacy and ease of use to be applied in place of the wettable powders.

The problem of extensive drift and space spraying in hot climates has stimulated investigations into the possibility of applying many of our common crop protection chemicals diluted directly with oil. This work has been useful not only in solving the evaporation problem, but also because it has been found that in many cases oil-based sprays offer distinct advantages.

Some recent work on bananas has helped to stress the importance of a careful selection of oil diluents. Under drought conditions applications of certain oil-based fungicides have led to severe leaf scorch. This scorch was the direct result of a lack of care in choosing the diluent oil. Fungicides based upon the right oil diluent have been applied many times under similar conditions without any trace of scorch developing.

Until recently it was doubted whether the systemic materials, such as organo - phosphorus insecticides, could be applied satisfactorily in the form of concentrate sprays. There is no doubt that the toxicity hazard is increased, but there is now sufficient evidence to show that, providing adequate precautions are taken, such spraying operations can be carried out successfully; furthermore, the systemic materials are just as effective when applied in very low volumes of total liquid per acre.

Some recent work has shown that the danger of drift damage to adjacent crops, when applying hormone-based selective weedkillers through concentrate equipment, is unlikely to be as great as was originally feared. Provided that there is a careful control of droplet size, and that the air beam carrying these droplets is correctly directed, there is little likelihood of any hazard beyond 50 yd., even in high winds. In the above experiments tomatoes were used as the indicator plants.

Importance of atomisation

After the initial successes of the concentrate system many people tended to neglect the fundamental principles and believed that they could merely reduce the volume of liquid applied per acre and still obtain effective control when employing machines incapable of providing adequate atomisation. One can, for instance, apply a gallon of spray to an acre of crop through a watering can, but it is unlikely that any lasting benefit will be obtained.

One of the most important lessons that has been learnt over the past six years is that an atomiser providing fine, even drops is absolutely essential if the concentrate spraying technique is to be adopted. Apart from the poor cover and consequently reduced control, which can result from inadequate atomisation, there is also a greater likelihood of producing phytotoxicity with the highly concentrated sprays. It has often been shown that materials which are suspect on the grounds of phytotoxicity can be successfully applied provided the atomisation is good, whereas they can produce considerable damage if the atomisation is bad, even when applied at extremely low volumes per acre. The development period has shown that the most important requirements of a concentrate sprayer are fine atomisation and that the fine droplets produced by the atomiser should be evenly dispersed through the largest volume of low-pressure air that it is possible to obtain.

When operating in crops where it is inevitable that some of the canopy of foliage is close to the outlet of the machine, it has been shown that a broad beam of air and droplets is less likely to produce scorch symptoms than a more intense and narrow beam. The broad beam also carries with it

the advantage of being able to cover large areas of the canopy with a small movement of the outlet; this means that the outlet can be moved more slowly and that the full volume of air emitted can be used to obtain maximum penetration.

Crop successes

Bananas.—The banana plantation industry was one of the first to adopt concentrate spraying on a wide scale. It is, therefore, not surprising that the banana is the economic crop which is being the most widely treated today. During the past year well over a quarter of a million acres have been treated, mostly with copper fungicides suspended in non-phytotoxic oils.

Cocoa.—The cacao industry in certain parts of the world has adopted the concentrate method for the control of such roving pests as the capsids. In this case BHC, dieldrin and endrin are being employed and trials are at present in progress to determine the efficacy of oil-based copper fungicides for the control of black pod.

Tea.—Recently, very encouraging results have been obtained in trials designed to determine the value of the concentrate system for the control of blister blight on tea, employing oil-based copper fungicides. Applications of as little as half a gallon of total spray per acre per round have shown a much higher degree of control than has been obtained with conventional techniques.

Fruit.—Fruit growers, too, in certain areas have over the past four years been determining the value of concentrate spraying both for their routine fungicidal treatments and for their additional insect and red spider control operations. The concensus of opinion is now in favour of the concentrate method.

Field crops.—More recently much work has been done on such field crops as runner beans, potatoes and broccoli, and in all cases it has been found that concentrate spraying is capable of dealing successfully with a variety of pest and disease problems.

A shoulder-mounted concentrate sprayer being used for applying sulphur to citrus

A New Research Station

At the National Vegetable Research Station in Warwickshire, England, research work is being done on the breeding of improved varieties of vegetables, the control of pests, diseases and weeds, the improvement and maintenance of soil fertility, on cultural methods and irrigation and on the efficiency of field experimentation.

The main station at Wellesbourne consists of 280 acres. The soil and climate are suitable for general research investigations on horticultural crops and are similar to those of the nearby Vale of Evesham, where vegetable production is an important industry. The sub-station at Paglesham consists of 150 acres and is to be used for the multiplication of seed and the investigation of relevant problems.

An association has been formed to advance the knowledge, science and practice of vegetable production. A member of the N.V.R.S.A. is able to keep in touch with the latest research developments at the station and members' days provide opportunities for the interchange of ideas between research workers and growers and enable members to see and discuss the work being done at the station, and to meet other growers with common interests. Further details may be obtained from the Secretary.

Banana Protection

Scab moth is estimated to ruin at least a quarter of Fiji's potential banana exports every year. A tiny parasite which feeds on the larvae of this pest is being introduced from New Guinea and, if experiments which have been made with the parasite are as successful in the plantations as they have been in the laboratories of the Department of Agriculture, the banana industry will be rid of its worst enemy.

The parasite has an enormous rate of reproduction and they will be launched in myriads near banana plantations affected by scab moth. It is hoped that within six months of the parasite attack the pest will be under control.

The idea that there might be a parasite which could control the scab moth came from an observation that the banana trees in New Guinea were free of this pest. The entomologist who was sent to search for this parasite found not one, but five, one of which was selected for mass reproduction.

Many months of research followed, as the Department had not only to make sure that the parasite would deal with the moth, but also that it would not attack other benevolent species of insects.

The parasites will be released by officers of the Department of Agriculture and into certain selected areas only. For the present there will be no general distribution to individual growers; insecticidal dusting will be continued in those areas into which the parasite is not being introduced.

THE ABC OF WEED CONTROL

The menace of weeds is as old as Man himself, challenging the very existence of crops by competing with them for sun, moisture and plant nutrients. In many countries overseas, chemical weed control is still regarded as having no place in the economy of the farm or plantation, but in all progressive countries weed control by chemicals is now a recognised farming operation.

THE full extent of the harm done by weeds is still not yet fully appreciated in all countries. The competition between weeds and the crop for air, light and moisture is very acute, particularly when the crop is young; in extreme cases the crop may be entirely overwhelmed, but generally there is a serious reduction in yield.

Every ton of weeds removes 3 in. of rainfall from the soil, and this is sufficient, in a dry period, to stunt the crop permanently so that it never becomes a healthy plant.

Furthermore, weeds crowd out and shade the growing crops, so hampering air circulation, encouraging damp conditions conducive to mildew, and, by cutting off light, reducing the production of food by photosynthesis. They also retard the ripening of the crop, by keeping the air around it too moist at the end of the growing period, when the crop is ripening. These factors together may well reduce the crop yield by one-fifth or even more.

Finally, the presence of weeds can materially reduce the nutritive value and palatability of forage crops and increase the mechanical difficulty of harvesting cereal crops with the combine-harvester and of obtaining clean grain. Some weeds are poisonous to grazing animals and others may cause digestive troubles, due to irritation by sharp seeds and thorns.

Classification of weeds

Chemical control of weeds depends greatly on the characteristics of the weeds themselves. They fall into two main classes—' annuals ' and ' perennials '. ' Biennials ' store food in the first year to meet the demands of seeding in the second and, if caught in the first year, may be treated as annuals. Annual weeds are prolific seeders, *e.g.* the poppy; they are quick-growing, with smallish rootstocks, and are easily controlled by cultivation, but, unfortunately, there are so many of their seeds lying dormant in the soil that movement caused by cultivation often starts the germination of a further crop of weeds.

Annuals are most vulnerable in the young seedling stage, as then they have no reserves. Defoliation will kill them. Thus they will succumb to the action of contact herbicides and they are also, of course, susceptible to the action of a root poison.

Perennials normally live for more than two years and are classified as 'herbaceous' perennials, *e.g.* the creeping thistle, whose leaves and aerial parts die back each year, growth being carried by the underground parts, and ' woody ' perennials, which have hard woody stems which persist from year to year, *e.g.* the bramble.

While some food is stored in the seeds of perennials each year, the major part is accumulated and stored in the vegetative organs of the plant to produce new growth in the following year or to make good any injury done to the plant. This large reserve of

Some common weeds

(Top) *The daisy*, Bellis perennis, *otherwise known as Bachelor's Buttons—a hardy perennial*

(Centre) *A luxuriant growth of cleavers*, Galium aparine. *Other names are Goosegrass, Burs, Sweethearts, Sticky Willy and Beggar Lice — a climbing annual*

(Bottom) *The broad-leaved dock*, Rumex obtusifolius, *an upright perennial weed which may take two years to kill*

Photos: Shell Chemical Co.

food renders perennials more difficult to control, since, while contact weedkillers will burn off the exposed parts, the roots are unaffected and will subsequently send up fresh roots. The weed is, however, checked by this treatment and this check is often sufficient to enable the crop to establish itself and will partly smother any growth of weed; but if the weed is to be killed entirely a root poison or a translocated or systemic type of weedkiller must be used.

Spread of weeds

Weeds can be readily spread by means of parts of the plant, *e.g.* surface runners, rhizomes or swollen roots and sections of stem. Some seeds, such as those of the thistle, are light enough to be wind-borne; others are often provided with hooks or spines, so that they may be carried from place to place by animals. The seeds of certain plants, such as the poppy, have a long soil dormancy and are able to stand years of burial. Some weeds are spread both by seed and by parts of the plant.

Seeds of weeds may also be introduced through using seed that has not been properly cleaned and is not of guaranteed quality. Weed seeds, present in litters, in compost or in farmyard manure, may also be carried on to the land when it is manured, as the seeds may germinate if these materials have not been properly broken down. Seeds are often in the excreta of livestock and wild birds, but only a few are capable of germination.

Weed control

The practice of using chemicals for the control of weeds dates back to Roman times, as Virgil described the use of common salt to prevent the growth of weeds. It was only in recent times—just over 50 years ago—that Bonnet in France first demonstrated that yellow charlock in a cereal crop could be controlled, without damage to the cereal, by spraying with copper sulphate. Subsequent progress was slow. Trials were made with various chemicals, selected at random, to determine their usefulness for agriculture, and it was found that the salts of iron, copper and potassium had the same toxic qualities as copper sulphate, and that dilute sulphuric acid was even more effective and less dependent on weather conditions for success. It was not until the 1930s that its use became at all widespread, and meanwhile the practice of weed control by dusting with kainit and cyanamide had also made headway.

Organic weedkillers

Subsequently, an organic chemical, -3,5-di-nitro ortho cresol, already in use as an insecticide, was developed in France as a weedkiller and, in about 1940, it was introduced into the U.K. for this purpose and is now known commonly as DNC. This was the beginning of the science of weed control.

Weedkillers used today may be selective or non-selective. The former are applied to growing crops with the object of killing the weeds without injury to the crop; non-selective weedkillers are applied where no crop is present or where it is not necessary to differentiate between the crop and the weeds.

Selective herbicides may be applied after sowing or planting, but before the crop has emerged from the ground, *i.e.* pre-emergence, or to the crop foliage after it has appeared, *i.e.* post-emergence. The latter are generally applied as overall sprays both to the crop and the weeds. They are of two types—' contact ' and ' translocated '. The former kill plant tissues in the immediate vicinity of a droplet of the weedkiller; translocated weedkillers may move within the plant away from the actual point of application. In general, these act more slowly than the contact weedkillers.

Non-selective weedkillers may also be ' contact ' or ' translocated '. Those in the former category are crude mineral oils, fortified with dinitro compounds or pentachlorophenol, and tar oils. Translocated non-selective weedkillers may be applied to the foliage or to the soil and may result in complete or partial sterilisation of the soil for a period depending on the chemical and the conditions of application.

The ABC

The use of abbreviations or ' common names ' to describe the basic ingredients of the various formulations offered by manufacturers of chemical weedkillers is for convenience only; they are not trade names, but are abbreviations of very complicated descriptive chemical formulae.

Following the use of DNC (see WORLD CROPS, 1957, **9**, 66 and 71)—the insecticide mentioned above—as a weedkiller, subsequent experiments on the effects of the new growth-promoting substances, known as the hormones, on plants led to the discovery of new weedkillers based on 2-methyl-4-chloro-phenoxy acetic acid, MCPA, and 2-dichloro-phenoxy acetic acid, 2,4-D (WORLD CROPS, 1953, **5**, 125). Further research was thus stimulated and a range of compounds based on the phenols was found to have a wide field of application. Di-nitro ortho secondary butyl phenol, commonly known as ' Dinoseb ', is now established as a weedkiller in peas and other legumes; pentachlorophenol, PCP, has applications for total and pre-emergence weed control and as a defoliant; oils are being developed for the control of weeds in carrots and other umbelliferous crops and in forestry nurseries; oils are also being used as ' carriers ' for other weedkillers, rendering the latter more potent.

A material which promises well for the future is trichloroacetic acid, TCA, which, being more toxic to grasses than to broad-leaved weeds, seems to provide the natural complement to MCPA and 2,4-D, and it has considerable advantages as a total weedkiller when used at higher rates. It is not yet established as a selective weedkiller owing to the erratic results obtained on different types of soil.

Another chemical, 3 - (p - chlorophenyl)-1,1-dimethyl urea, CMU (see WORLD CROPS, 1957, **9**, 328), is giving encouraging results as a total destroyer of weeds and 2,4,5-T, a close relative of 2,4-D, with which it is usually formulated, is now coming into general farming practice for the control of bramble and scrub growth. It is useful for keeping ditch banks and hedge bottoms clean (see WORLD CROPS, 1957, **9**, 325).

The herbicides CDAA and CDEC (see WORLD CROPS, 1957, **9**, 72) have now been proved effective in controlling wild oats in barley, when applied as a pre-sowing or post-emergence treatment. In peas and sugar-beet CDEC was the more effective of the two.

While DNC formulations have provided an effective control for cleavers in cereal crops, they are not entirely satisfactory because of their poisonous nature. The need for a safe herbicide has now been met. Early in the year

two new products were announced for the control of this troublesome weed—'Monoxone' (WORLD CROPS, 1957, **9**, 356), a contact weedkiller, and CMPP (WORLD CROPS, 1957, **9**, 74), a translocated weedkiller.

These basic ingredients, as well as others listed below, are sold under various trade names in various formulations designed to improve their selectivity and effectiveness. The products offered by reputable companies have been subjected to extensive tests before being placed on the market, but it needs to be emphasised that the results obtained with these products in the field are dependent on their application strictly in accordance with the instructions given with the container or package.

It is not possible in this short article to give more than a very condensed account of the present position with regard to the control of weeds by chemicals. Its purpose is to arouse interest in the subject and those so interested are referred to the following publications for further information:

'Proceedings of the Third British Weed Control Conference of 1956'. 2 vol. 42*s*.

'Common Farm Weeds Illustrated'. Plant Protection Ltd. 1952, Butterworth. 15*s*.

'Weed Control in Farm and Garden'. 1954, S. J. Willis. Vinton & Co. Ltd. 8*s*. 6*d*.

'Shell Selective Weedkillers'. 1956, Shell Chemical Co.

Weed Control Handbook, 1957. British Weed Control Council. 5*s*.

Organic Herbicides
(arranged in alphabetical order)

Common name	*Full chemical name*
CDAA†	2-chloro-N,N-diallylacetamide
CDEA†	2-chloro-N,N-diethylacetamide
CDEC†	2-chloroallyl diethyldithiocarbamate
CIPC†	isopropyl N-(3-chlorophenyl) carbamate
CMU	3-(p-chlorophenyl)-1,1-dimethyl urea
4-CPA†	4-chlorophenoxyacetic acid
4-CPB	4-(4-chlorophenoxy) butyric acid
2,4-D*†	2,4-dichlorophenoxyacetic acid
3,4-DA†	3,4-dichlorophenoxyacetic acid
dalapon†	2,2-dichloropropionic acid
2,4-DB	4-(2,4-dichlorophenoxy) butyric acid
DCU†	dichloral urea
2,4-DEB†	2,4-dichlorophenoxyethyl benzoate
2,4-DES†	sodium 2,4-dichlorophenoxyethyl sulphate
dinosam*	4,6-dinitro ortho secondary amyl phenol
dinoseb*	4,6-dinitro ortho secondary butyl phenol
diuron†	3-(3,4-dichlorophenyl)-1,1-dimethylurea
DNC*†	3,5-dinitro ortho cresol
endothal†	3,6-endoxohexahydrophthalic acid
fenuron†	3-(phenyl)-1,1-dimethylurea
MCPA*†	2-methyl-4-chlorophenoxyacetic acid
MCPB	4-(2-methyl-4-chlorophenoxy) butyric acid
MCPES†	sodium 2-methyl-4-chlorophenoxyethyl sulphate
MH†	maleic hydrazide
monuron†	3-(4-chlorophenyl)-1,1-dimethylurea
neturon†	3-(3,4-dichlorophenyl)-1-methyl-n-butylurea
NPA†	N-1-naphthyl phthalamic acid
PCP†	pentachlorophenol
PMA†	phenyl mercuric acetate
propham*	isopropyl N-phenylcarbamate
simazin	2-chloro-4,6-bis(ethylamino)-s-triazine
2,4,5-T*†	2,4,5-trichlorophenoxyacetic acid
2,4,5-TB	4-(2,4,5-trichlorophenoxy) butyric acid
2,3,6-TBA †	2,3,6-trichlorobenzoic acid
TCA†	trichloroacetic acid
2,4,5-TES†	sodium 2,4,5-trichlorophenoxyethyl sulphate
2,4,5-TP	2-(2,4,5-trichlorophenoxy) propionic acid

*common name approved by B.S.I.
†approval given by the Weed Society of America.

Pyrethrum flowers being harvested in the highlands of Kenya to be later processed i1 the Nairobi factory

Pyrethrum

Nature's Own Inseticide

Pyrethrum is not only one of the oldest, but also one of the most valuable insecticides. It has the valuable property of being non-toxic to Man, while being effective and rapid in its action against a wide range of insects.

Pyrethrum is a daisy-like flower—a member of the chrysanthemum family

THE visitor to the highlands of East Africa and the Belgian Congo can see thousands of acres between altitudes of 5,000 and 10,000 ft. covered with what at first sight might appear to be snow. There are everlasting snows to be found close to the Equator, but in this case the ' snow fields ' are really vast areas of daisy-like flowers, known as pyrethrum, *Pyrethrum cinerariaefolium*. A member of the chrysanthemum family, it thrives at these altitudes in tropical latitudes, and particularly in the mountains of East and Central Africa, which allow the plants to flower for about nine months of the year.

History

Tracing the early history, pyrethrum flowers for insecticidal purposes apparently originated in Persia. The species was probably *Pyrethrum roseum*, which was introduced into Europe in the early 19th century and used for the production of ' Persian Dust '. Accounts of the discovery differ, but it has been established that it was used in Europe about 130 years ago and much earlier in Persia.

Growing pyrethrum for insecticidal purposes was confined to Dalmatia until 1914, when, with the outbreak of war, supplies were curtailed. Japan then entered the field and started growing flowers and she continued to hold the market for many years. It was not until about 1928 that pyrethrum was introduced into Kenya, the industry becoming established by 1932, where it has flourished ever since, apart from the setbacks already mentioned. The second world war caused Japan to drop out of the market in 1940, leaving Kenya to supply the free world. Recently (1950) Japan again started exporting flowers and in 1953 over one thousand tons were exported.

The bulk of the pyrethrum used today is still supplied by Kenya and nearly 700 farmers are growing pyrethrum on more than 20,000 acres of land in East Africa alone. The crop is now also grown in the Belgian Congo, Japan and Brazil.

The plant

Pyrethrum is a plant bearing small daisy-like flowers on tall stems. From these flowers are extracted pyrethrins, which make a very active insecticide. In the early part of the century it became clear that a cheaper and more effective way of using pyrethrum than in powder form would be as a liquid spray made by extracting from the flowers the pyrethrins, which are soluble in a number of solvents, including mineral oils.

The pyrethrum extraction business which thus came into being has progressed step by step with the world supply of flowers and the growing demand, particularly since the last war, for pyrethrum-based insecticides.

Before the second world war there was no thought of converting the East African crop of flowers into extract on the spot. Instead, pressed bales of dried flowers were shipped overseas, mainly to America and the U.K., for processing in plants established in those countries. During the war the lack of shipping and the need for insecticide for service use led the Government seriously to consider the extraction of the flowers in Kenya.

In 1945 the story was taken a stage further with the building of the first extraction plant in Nairobi and it reached an outstanding climax in 1956 with the announcement of a new discovery which will enable this plant to increase its capacity to more than 7,000 tons of flowers per year. The factory has five hydraulic presses each capable of baling seven tons of flowers per eight-hour shift. There are also grinding mills for making various grades of pyrethrum powder.

Uses of pyrethrum

Pyrethrum is probably best known for its high efficiency against house flies and very large quantities of it are used in fly sprays and aerosols. It is also known for its efficiency against cockroaches, fleas, bugs and other household insects. Between the wars it was used extensively for the control of crop pests, but the introduction of the chlorinated insecticides curtailed its use in this field of insect control, as they were cheaper and had greater stability than pyrethrins.

The use of pyrethrum for the control of insect pests attacking foodstuffs goes back some 20 years and followed the work of Potter when he established the use of pyrethrins in white oil, applied as a mist and as a residual film, for the control of moths attacking dried fruit. Now pyrethrum, usually in combination with a synergist, is used extensively in the food industry for the control of a wide range of pests.

Synergists

Pyrethrum is now rarely used by itself, but more generally in combination with a synergist. The newer synergists are much more powerful than those used in the past. The early synergists, for example, sesamin, when combined with pyrethrins, increased the potency of pyrethrins by only a small amount, whereas the newer ones can increase the potency by as much as 15 times and more. The first of the post-war synergists to be developed was piperonyl butoxide (butyl 3:4-methylenedioxy - 6 - propylbenzyl - diethyl-eneglycyl ether), but there are now several others, including ' Sulphoxide' (n-octyl sulphoxide of isosafrole), ' Octacide 264 ' (N-2-ethyl hexyl bicyclo-(2.2.1.)-5-heptene-2,3 dicarboximide) and ' N propyl isome '. These materials are only slightly toxic to insects, yet when combined with small amounts of pyrethrins the biological efficiency of the mixture is greater than the added efficiency of the pyrethrins and the synergist when used separately. The ratios of pyrethrins : synergist normally used are from 1 : 2 to 1 : 20.

Agricultural applications

As living standards rise more time and money are devoted to improving health and hygiene, protecting foodstuffs from contamination, and combating disease. One aspect of the immense problem of world health is the amount of research which is being conducted into methods of protecting populations, and crops and livestock from harmful insect pests. War is being waged against the legions of flies which spread diseases, such as poliomyelitis, tuberculosis and bacillary dysentery. Mosquitoes, the vectors of malaria and yellow fever, are also the subject of a world-wide campaign.

Pyrethrum is incorporated in a wide range of formulations used in agriculture and horticulture, including sprays for livestock and cattle; dairy sprays, crop and garden sprays and sprays for fish, meat and vegetable markets. Pyrethrum dust is used in poultry house powders, flea powders, cattle louse powders, in delousing greases and in pet shampoos.

Research

A Kenya Pyrethrum Board has been set up with full powers to regulate the industry and it imposes a levy for research of a few cents per pound on flowers delivered. Research stations have been established in the main pyrethrum-growing areas, where investigations are proceeding into such subjects as fertilising and manuring, mulching, spacing, pruning, selection and planting methods. Plant breeding for improving yields and toxicity is carried out at the Agricultural Plant Breeding Station at Njoro.

Abstracted from a paper by K. F. Godwin Bailey given to the Industrial Pest Control Association on 6 October, 1954, and from ' East African Agriculture ' by J. K. Matheson and E. N. Bovill.

Names for Pesticides

A revised edition of B.S. 1831 brings together the two parts of the standard originally published separately in 1952 and 1953 respectively and supplements them with many more coined names. The new edition contains 64 short common names which are recommended for easy identification of well-established pest control chemicals, whose chemical names are often long and difficult to pronounce.

Four classes of pesticides are dealt with: (1) insecticides, (2) fungicides, (3) herbicides and (4) rodenticides. The names are not proprietary, though they have been recorded—but not registered—as trade marks by the British Patent Office. B.S.I. invites manufacturers to put forward common names of their own for consideration by the technical committee responsible for B.S. 1831. Additions to the standard will be issued from time to time.

B.S. 1831 may be obtained from the British Standards Institution, 2 Park Street, London, W.1, price 7*s.* 6*d.*

Training for Overseas Students

Progress in the crop protection field has been very rapid since the war. It has been difficult even for specialists in England to keep pace with all the new products brought on the market and it is obviously impossible for people working in overseas territories to keep completely up to date with all the developments in this vast field.

This year 25 people were nominated to attend the course arranged by Fisons Pest Control Ltd. at the Chesterford Park Research Station, from Kenya, Tanganyika, Uganda, British West Indies, Malaya, Sierra Leone, Nigeria, Mauritius, India and the Sudan.

The course included lectures on the latest methods of control of insect pests, diseases and weeds on all the important cash crops in these territories as well as on the best types of equipment to use, together with practical instruction in its use and maintenance.

Coming Events

Trade Fair and Exhibition.—An International Industrial Trade Fair and Exhibition is to be held at Hermosillo in the State of Sonora, Mexico, from 3 November to 8 December.

Smithfield Show.—The Smithfield Show and Agricultural Machinery Exhibition will be held this year from 2–6 December at Earls Court, London. Readers are particularly invited to meet us at WORLD CROPS Stand No. 60.

Soil Science.—The Soil Science Society of the Philippines is to sponsor the 1st South-East Asia Soil Science Conference in Manila from 9–22 December. The theme of the conference will be ' the importance of soil science in the agricultural development of the South-East Asian countries ', and it is hoped this will foster active co-operation in solving common problems involving management of tropical soils and in the promotion of research to increase the productive capacity of soils.

Work Study.—A conference organised jointly by the Association of Agriculture, the British Institute of Management and the Institution of British Agricultural Engineers will take place on 19 February, 1958, at 21 Tothill Street, London, S.W.1. Its purpose is to provide a full-scale opportunity for the exchange of information between industry and agriculture on the important subject of making the most of time and energy. The conference will be opened by the Rt. Hon. Reginald Maudling, M.P., Paymaster-General.

Silage.—An opportunity to study recent developments in machinery and the methods used in silage making will be provided by a National Silage Demonstration on 21 and 22 May, 1958, near Basingstoke, England, to be organised by the Shell Chemical Co. The Advisory Committee includes representatives of the Ministry of Agriculture, the National Institute of Research in Dairying and the National Institute of Agricultural Engineering.

Progress in the Dominican Republic

A pattern for tropical countries

AGRICULTURAL revolutions can sometimes be a mixed blessing but it is difficult to find fault with the policy of Generalissimo Trujillo who in the last 27 years has radically altered the whole economy of the Republic. When he came to power the country was not producing anything like as much as it could. The main crop was sugar-cane and the profits of the farmers fluctuated with changes in the unstable world market. Much food had to be imported.

Agricultural history

Before considering the means by which the President succeeded in placing the agricultural economy of the country on a broader base and made it self-supporting, it might be worth reminding ourselves of some of the history of Dominican farming. The Spanish Conquistadors when they arrived at the end of the 15th century found maize, sweet potatoes, groundnuts, hot peppers, pineapples, sisal, cotton and tobacco. Of the latter a Spaniard said 'a highly-prized weed (tobacco), cultivated by the natives in their orchards and gardens . . . , giving us to understand that to take of this weed was not only healthful, but also very holy'.

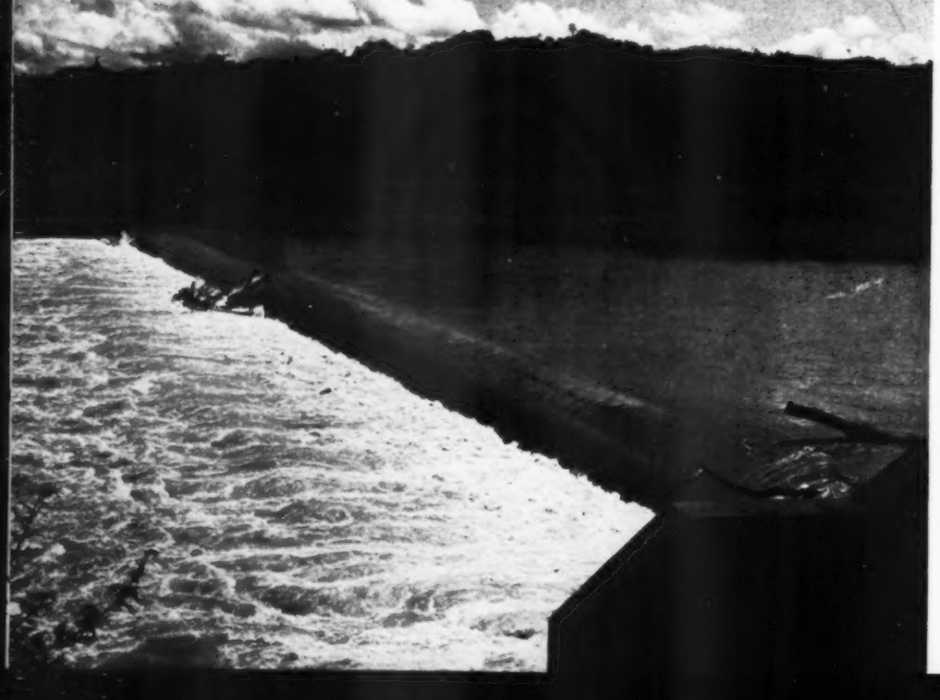
A caterpillar tractor pulls a sprayer which is applying Bordeaux mixture to a banana plantation. This is a treatment for Sigatoka, a banana plant disease, and the fruit as well as the tree is sprayed

La Isabela on the north coast was the first agricultural centre of the New World and here European fruits were planted 'in order to test the land' wrote Columbus, 'which appears to be excellent'. We are told that lettuces, cabbages, turnips, melons and squash were planted here and there seems little doubt that America owes many agricultural products (including oranges, lemons and limes) to this pioneer testing ground.

Sugar-cane, on which the country came to depend overmuch, was introduced successfully in 1506, brought from the Canaries. From this source also came bananas in 1516—another first in the New World.

Dominica today

The Dominican Republic is roughly the size of Scotland with 2½ million inhabitants, about 90% of whom are concerned in agriculture or processing its products. Generalissimo Trujillo setting out to reform and bring prosperity to his country had as his first objective the raising of the low standard of the rural economy. Peasant farmers were making a bare living from the land and great areas were undeveloped. Under a programme of land colonisation, 250,000 acres came under cultivation for the first time through provision of 52 irrigation



By means of canals and aqueducts water has been diverted to create over 250,000 acres of farming land in eastern and southern regions. Seen here is the Yuna canal, one of the most important of the group of 52 canals

canals costing £5 million. Irrigation schemes are still being developed and thousands more acres will come under cultivation.

The new lands made available by the government together with farmhouses, equipment, seeds and initial allowances were allotted to *collective* farms but in 1953 under new legislation the settlers were given economic units of land, with the result that there are now thousands of flourishing *independent* farmers. A similar plan split up the 200,000 acres of richest sugar-cane land which had previously belonged to five big sugar mills. *As part of the resettlement policy displaced Jews and Hungarians from Europe as well as Japanese have been granted land in the newly-irrigated areas. Their example and the new techniques they have brought with them has done much to educate the native farmers.* Close contacts are maintained with the individual farmers through the local branches of the Department of Agriculture. The Department maintains nurseries to produce trees for afforestation as well as new and better varieties.

Mechanisation has been achieved by State subsidy and the sharing of implements and tractors. A bank of agricultural and industrial credit was established in 1943. *It now handles over* $100 *million and has made possible the farm development that enables the Republic to export over seven times as much in agricultural products as she did in* 1930 *as well as support an almost doubled population.* Whereas previously sugar was the main item, in 1956 through the policy of encouraging diversification, other crops were fast catching up including coffee worth £11,700,000, cocoa (the Republic is the second largest producer in the Americas), tobacco, cotton and sisal. For the first time over a million tons of sugar were produced: Britain was the best customer taking £12,692,000 worth.

Efforts to achieve self-sufficiency in foodstuffs have not only been valuable to the Republic but also to other West Indian countries. During the war food supplies from the Republic were vital to her neighbours, a fact recognised by the Germans who sank half the Dominican merchant navy. Much care has gone into the development of ranching through the introduction of pedigree stock. It is estimated that there are now a million head of cattle and more than a million pigs in the country. In the coming years the Republic will be a main meat supplier for the Caribbean. Rice, which plays an important part in the national diet, was previously all imported but now 40,000 tons are grown annually and there is enough left over for export.

Success story

The favourable trade balance —imports £38,604,000, exports £45,171,000, *is entirely due to the success of the agricultural policy. Heavy capital investment by the government on irrigation, mechanisation, equipment of new farms and education* (illiteracy once 90% has now been eradicated) *has paid tenfold. It is the sort of success story that will have to be repeated in tropical countries all over the world to keep pace with the rise of population.* Certainly a long-term plan cannot be put into effect without government control and investment. The Dominican Republic is to be congratulated in having a far-sighted leader who over the years has carried out a realistic, but revolutionary, policy of agricultural encouragement.

The figures in Table 1 speak louder than words. Well done Republic of Dominica !

Table 1

The trade balance of the Dominican Republic
Export and import figures

	Export: agricultural products	*Import: machinery, consumer goods*	*Favourable balance*
1925–29 (today's monetary equivalent)	$135,336,000	$126,318,000	$9,018,000
1951–55	$573,976,000	$422,906,000	$151,070,000

Rich grazing land has encouraged large-scale ranching and efforts have been made to import good stock. Meat production has doubled since 1930

NEW PUBLICATIONS

Tobacco Diseases and Decays

By Frederick A. Wolf. Pp. xvi + 396. Durham, N.C., U.S.A.: Duke University Press (for whom Cambridge University Press act as agents). 1957. Second edition, 56*s*. 6*d*. or $7.50.

The formidable list of a hundred and more diseases listed in Dr. Wolf's book, as the author points out, arises partly from the fact that tobacco is now cultivated in so many countries. It is essentially a plant of warm climates, but, in one form or another, has been adapted to grow under a wide range of conditions; hence its occurrence as a field crop, not only in the tropics and sub-tropics, but also at high latitudes, as in Canada and Sweden, where the summer is hot and not too rainy. Furthermore, there is great diversity in the methods of cultivating tobacco, due to the special requirements of the different types—cigar filler, cigar wrapper, flue-cured, Burley, Turkish, dark tobacco etc.—which have been developed to meet special needs, and this leads to considerable variation in the impact of pathological and nutritional problems.

The arrangement of the text is the one which is usually adopted in works on systematic plant pathology, *i.e.* diseases are grouped according to the nature of the causative agent. Hence the chapters on diseases caused by viruses, by bacteria and by fungi; these, from their importance, occupy more than half the book. There are shorter accounts of nutritional disorders, in particular of those caused by deficiency or excess of certain mineral elements; of chemical injuries resulting from the use of certain soil disinfestants, fungicidal sprays or dusts; of nematode-induced diseases which may be important in themselves, but increase in importance when associated with certain fungal diseases; of the interesting though usually not economically important diseases caused by higher-plant parasites (dodder, broomrape etc.); and of fungal troubles which arise in the process of curing and handling the tobacco leaf after harvesting.

The description of each disease, too, follows the standard pattern: diagnostic symptoms, brief account of the causal organism (if present), seasonal and geographical occurrence, and practical control measures. With regard to the last, one cannot fail to be impressed by the high measure of success which has been obtained by the breeding of suitable resistant varieties of tobacco. As many of the diseases of microbial origin are most serious when the plants are attacked in the seedling stage, a special chapter is devoted to the proper management of seedbeds and, as weather has a predominant influence on the growth of crops, both by its direct action and by its effect on the severity of microbial attack, there is a special chapter on this also.

' Tobacco Diseases and Decays ' is essentially a book for the expert, scientific worker or progressive farmer concerned in the cultivation of the tobacco plant. To such it can be recommended with the fullest confidence. The author has devoted the work of a lifetime to the study of this crop and is undoubtedly the world's leading authority on the subject. Despite the specialised nature of the book, there are sections of it which would stimulate the interest and curiosity of the general student of plant pathology, and the plant physiologist interested in growth phenomena would do well to read the section on abnormal growth forms. The etiology of ' frenching ' has been much debated and it is only recently that the claim has been made that the disease is due to absorption of certain amino-acids produced by a saprophytic bacterium in the neighbourhood of the plant's roots. If this explanation is confirmed, it offers another nice problem to the plant physiologist.

W. BROWN

Citrus Growing in Australia

By F. T. Bowman. Pp. 311, illustrated. London: Angus and Robertson. 1957. 63*s*.

The present success of the citrus industry in Australia owes much to the enthusiasm of a succession of pioneer planters over the past 150 years. In more recent decades their skill has been supplemented by that of scientists, the value of whose work is perhaps disproportionate to the importance of the citrus industry in that country, for although present Australian production is about seven million bushels annually, this represents only 1% of world production. The high quality of research work in Australia, however, coupled with excellent cultural practices, has enabled Australia to export fruit of a quality which bears comparison with her competitors in world markets.

Such being the case, publication of a comprehensive account of citrus growing Australia, which incidentally brings out the above statement, is of more than local interest. Basic principles pertaining to citrus production are common to growers in all countries, but there remains the technique of fitting such principles to different climate and soil conditions. These differences are responsible for the characteristic productions and practices in Australia where the crop is grown under very diverse conditions in the various States of that enormous country, although the three largest producing areas are to be found in the south-west of the Continent. The great differences of climate and soil under which the crop is successfully grown in Australia make this book particularly valuable to growers in other countries. About half of the Australian crop is grown with the aid of irrigation and one is impressed with the completeness of irrigation facilities and the skill with which moisture is regulated with due regard to the requirements of the crop and the nature of the soil.

Books of this nature usually follow a somewhat similar pattern; where many fail is in ambiguity and presentation of incomplete descriptions. While the present author follows the usual pattern he avoids these pitfalls. He approaches his subject from the points of view of both the experienced grower who requires a manual to which he can turn for guidance from time to time and the novice who values a book which gives him complete information.

The early chapters outline the history of the industry and are followed by sections on classification of varieties, on selection and on propagation of rootstock. The effects of climate, soil and water in different parts of the country are discussed and related to the selection, design and development of the plantation. The practical nature of the book is perhaps best exemplified by the author's insistence throughout, implied even when not expressed, that the grower's objective is the production in the most advantageous season of a first-class variety of fruit, suited to a

particular market. It is by appreciating the potentialities as well as the limitations of soils and climates in the different districts that the grower can satisfy an all-the-year round demand for citrus fruits.

The book is written by a scientist of over 30 years' experience of citrus culture in Australia. The reader is therefore assured of a manual which will command world-wide respect. Dr. Bowman's book is, in fact, an authoritative and concise treatise, practical, aptly illustrated and eminently readable. The publishers are equally to be commended on the excellence of production.

D. H. GRIST

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Commonwealth Economic Committee

Total production of grain outside the Soviet Union and China reached a record figure in 1956-57, according to the latest issue of the Commonwealth Economic Committee's 'Grain Crops'; output of wheat was less than in some earlier years but maize, barley and rice all rose to new high levels. Exports of grain were a record in 1956, most of the increase being in shipments of wheat, especially from North America, although trade in barley, maize and rice was also exceptionally high. Western Europe imported substantial quantities of grain in 1956, while India and Pakistan were also large importers; Japan took less rice, but more barley, than in the previous year. Stocks of wheat at the end of the 1955–56 season were slightly below those a year earlier, despite an upward trend in Canada; stocks of oats in the U.S.A. were large, while those of barley and oats in Canada showed a renewed increase. Rice stocks were reduced in Asia during 1956 but they remained heavy in the U.S.A.

While output of grain as a whole was at a high level in 1956–57, that of wheat, at over 127 million tons, did not equal the totals of 1952–53 and 1953–54 because of frost damage in Europe. The record maize production of 130 million tons in 1956–57 was due mainly to the large crop in the U.S.A., while the heavy barley crop in Western Europe largely accounted for the record total for that grain; the large world output of rice, estimated at 85 million tons, reflected a recovery in Asian production. Oats and rye production, however, showed some decline from the totals reached in 1955–56.

Obtainable from H.M.S.O. or the Commonwealth Economic Committee, price 5*s*.

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Capital and Credit

As Mr. J. O. Jones states in his introduction to ' Capital and Credit in Agriculture ', Vol. II, No. 3, of the *International Journal of Agrarian Affairs*, ' For production to be maximised from given resources of land, labour and other raw materials, it is essential that available capital should be distributed in the right form and in the right proportions amongst the various productive enterprises '. Papers describing the formation and use of capital in agriculture in Denmark, Norway, Sweden and the U.K. have been contributed, which will not only be of mutual interest in these countries, but will also be of value to less developed countries with predominantly agrarian economies which are attempting by deliberate control and planning rapidly to increase the living standards of their peoples.

Published by Oxford University Press, price 5*s*.

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South Pacific Commission

' The Rhinoceros Beetle in Western Samoa '. The ecological studies described in this report are a part of the work being undertaken in the Commission's rhinoceros beetle research project. Investigations are proceeding concurrently in other areas where this pest is established. In the present report ways are suggested whereby coconut palms may be grown so that they present a maximum, or at least an increased, resistance to the effects of the beetle. It should therefore become possible to introduce alleviating measures in areas already affected and to take steps to fight the eventuality in areas where the pest may be expected. Price 4*s*.

' Parasites and Predators introduced into the Pacific Islands for the Biological Control of Insects and other Pests '. The regulation of pests by the introduction of parasites and predators has been widely applied in the Pacific, where it has had some striking successes. Four lists are given in which the records available are classified in four different ways, so that it is possible to obtain the information desired irrespective of whether the starting point of the enquiry is the island, the parasite, the pest or the plant. Altogether attempts have been made to introduce about 140 species of parasites and predators and slightly over half of these have been reported to have established themselves. Hawaii is not included. Price 2*s*.

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FAO Publications

Tree Planting Practices in Tropical Asia, Forestry Development Paper No. 11, deals with seed, nursery and planting practices and the characteristics of the species most commonly found in this region. Its purpose is to summarise the methods of artificial restocking of forest lands. The countries covered—Burma, Ceylon, India, Indo-China, Indonesia, Malaysia, Thailand and the Philippines—are considered in three groups according to the features of climate and stand formation. Price 10*s*. or $2.00.

Report of the Third Regional Conference for Asia and the Far East. This conference was held in October 1956 to consider the future orientation of FAO's work in this region. Besides considering future work, the report contains a review from each country and of the major policy questions of regional interest. Price 5*s*. or $1.00.

Calorie Requirements, Nutritional Study No. 15, is a further contribution to the study of this subject. The methods of allowing for the influence of age and climate have been modified, since the report published in 1950, and greater attention is now given to the relationship between activity and requirements. Price 3*s*. 9*d*. or $0.75.

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Hop Research

The Annual Report for 1956 of the Wye College Department of Hop Research describes in detail the work done during the year. Unfortunately, the bad summer seriously interfered with research by reducing plant growth and yields and largely eliminating many varietal and experimental treatment effects. An attack of *Verticillium* wilt has since been found to be due to a non-progressive strain. The breeding of wilt-tolerant varieties has continued. It is hoped that during 1957 a final selection of three or four will be made in preparation for large-scale farm trials, due to begin in 1959–60. Spraying trials confirmed that captan

gives as good control of downy mildew as copper; it has been found, however, that captan residues on hop cones may cause serious tainting in *dry*-hopping and captan should not be applied to *ripening* hops. Obtainable from the Secretary, Wye College, nr. Ashford, Kent, price 5*s*.

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Agricultural Research Index, 1957

This third edition of the Index covers almost all State-aided agricultural research in the U.K. Information is listed in two ways: a classified subject index brings together items in the same fields of enquiry; and crop and animal indexes list research work directed towards improved production in particular types of crops and livestock. The arrangement of the subject index has been changed to conform with the recommendations of FAO, who have asked all member countries in Europe to prepare similar registers of their agricultural research. Thus the British Index, though compiled primarily for the use of British research workers, will be more convenient in its new form for the international exchange of information.

Published by Cambridge University Press, price 12*s*. 6*d*.

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Handbook of the Insect World

This booklet presents in a single volume concise descriptions, drawings and approximate sizes of some of the most common insects. It is, of course, impossible to illustrate every insect in 60 pages. Although an insect primer, it is, however, sufficiently complete to be used as a guide by farmers, gardeners, students, Young Farmers and amateur collectors.

We live in a world teeming with insects. At least 686,000 known species, plus an additional 9,000 species of ticks and mites, compete with man. Each of these thousands of species numbers millions, even billions. Man's future on this earth may well depend on how well we understand the insect world—how well we fight our insect enemies—how well we protect our insect friends. The more we know about the world of insects, ticks and mites the better chance we have of protecting ourselves against them.

Copies of this book may be obtained through our Reader Service.

Weed Control Conference, 1956

The proceedings of the Third British Weed Control Conference held at Blackpool in November 1956 and reported in WORLD CROPS, February 1957, have now been published in two volumes. The papers presented at the conference are here published in full.

Obtainable from the British Weed Control Council, Cecil Chambers, 86 Strand, London, W.C.2, price 42*s*.

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Cacao Breeding Conference

The five sessions of the Cacao Breeding Conference held at the West African Cocoa Research Institute at Tafo, Ghana, in October 1956, considered breeding for disease resistance; plant breeding policy; techniques of breeding; the required characters for the field; and quality. The papers presented at each session are published in the proceedings, which includes a statement by G. D. H. Bell and H. H. Rogers, of the Plant Breeding Institute, Cambridge, outlining the main considerations and problems underlying the breeding work at W.A.C.R.I.—past, present and future. In his summing up at the conclusion of the conference, the chairman remarks that plant breeding can provide the answer to many of the difficult problems which are limiting production, provided there is a clear lead on the requirements of the industry.

Published on behalf of the W.A.C.R.I. by the Crown Agents for Overseas Governments and Administrations, 4 Millbank, London, S.W.1, price 7*s*. 6*d*.

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Long Ashton

The Annual Report of Long Ashton Research Station for 1956 is in six sections. The first section—pomology—gives a revised list of recommended varieties of cider apples, a progress report on the use of growth substances as thinning agents for apples and a comparative study of the propagation of gooseberries by softwood cuttings and by layering.

The second section—plant nutrition—describes the effects of cover crops on young dessert apples at Long Ashton. Compared with clean cultivation, the covers markedly depressed tree vigour and the nitrogen status of the leaves. Further manurial trials with strawberry show that, like Climax, the variety Royal Sovereign needs adequate supplies of potassium; the nitrogen requirement is low and fertiliser phosphate is effective only in the early stages after planting.

In the third section—plant pathology—an account is given of various spraying trials carried out at Long Ashton in the period 1953–56. Of special interest is the study of the surface waxes on apple leaves and fruits which may give resistance to fungal infection.

In the next section amino-acid content in relation to the growth of lactic acid bacteria in cider and fruit juices is studied.

In the fifth section there is a comparison of some varieties of fruits and vegetables preserved by canning and freezing; and the final section gives meteorological records for 1956.

Technical News

Articles appearing in the November issue of some other journals of the Leonard Hill Technical Group include the following:

Dairy Engineering. — 'Brushes in Dairy Cleaning Operations' by S. M. Charlett, 'New Developments in Ice Cream Manufacture', 'Instrumentation as Applied to the Production of Evaporated and Dried Milk, Part 2' by C. M. V. Benwell.

Atomics. — 'Nuclear Progress in Germany', 'Radiochemical Developments' by Prof. Seelmann-Eggebert, 'Nuclear Power and Energy Economy' by Minister Prof. S. Balke.

Automation Progress. — 'Automatic Equipment Produces Electric Motors', 'A Low Power Information Storage Device' by D. S. Campbell, 'Control and Instrument of a New Oil Refinery' by W. C. Gardner and J. E. Leary.

Bookshop Service

All books reviewed in WORLD CROPS *and all other scientific or technical books may be obtained from:*

Technical Books,
308 Euston Road,
London, N.W.1
Telephone: Euston 5911

Prompt attention is given to all orders

MACHINERY AND EQUIPMENT

Picture showing the sleek lines of the 'Sta-Dri' and its perfect all-round visibility

Tractor Cabs

The 'Sta-Dri' tractor cabs are simple in design and construction and when dismantled for shipment take up very little space—only 45 in. × 45 in. × 12 in.

Special features are: (1) all-round visibility which enables the operator to see fully whatever work he is doing, while he is fully protected from wind and rain; (2) easily-removable doors and roof which provide maximum coolness during hot weather and at the same time give protection from flying insects, jungle vegetation and the branches of tree crops.

A fibreglass roof is standard and the roof and doors can be lifted off in a matter of seconds, making the 'Sta-Dri' an all-weather cab suitable for both hot and cold climates.

'Sta-Dri' cabs are available for Fordson, Ferguson, Nuffield and International B.250 tractors.

Heating Greenhouses by Forced Draught

Natural convection is a very slow process, even in a greenhouse not impeded by staging, pots, plants etc.; when these are introduced they check natural convection and tend to create local 'cold spots', where no air movement can take place.

In consequence heat distribution within the greenhouse is poor; and the temperature rise is slow because the heater itself must first warm up before the process of natural convection can start.

The 'Live-Air' principle of the McAllan heater gives a quicker heat-up because of more efficient heat distribution. The air is constantly, though imperceptibly, circulating and does not depend for the spreading of warmth on natural convection alone.

The McAllan 'Live-Air' turbo heater is fitted with a powerful fan, which is capable of displacing 250 cu. ft. of air per min. It blows warmed air at ground level right to the end of the greenhouse, where, aided by natural convection, it rises to the top of the greenhouse and so rapidly displaces the cold air there. In the meantime, the cold air, instead of relying on natural convection to return it to the heating appliance, is drawn swiftly down and through the cold air intake of the turbo heater, which then reheats it and passes it out again into the greenhouse.

Reader Service

For further information on any item of machinery or equipment reviewed in this issue please write to:

Reader Service,
WORLD CROPS,
Leonard Hill House,
Eden Street, London N.W.1,
England

The McAllan turbo heater operates on the 'live air' principle

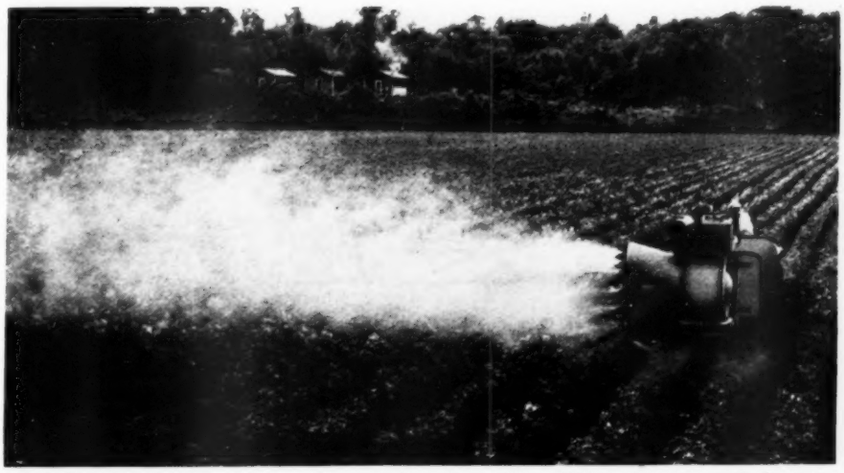
Air-type Spraying Attachments

The operation of John Bean Model 15RC-F attachments, for converting high-pressure sprayers into air-type row-crop units, has been further simplified by the addition of hydraulic remote controls.

The 'Aircrop' provides all the advantages of air-type spraying, even for growers with limited acreages, and the mechanical, hand-operated controls have been replaced by rotation control which operates directly through the tractor hydraulic system.

The Model 15RC-F 'Aircrop' attachment, featuring a 29-in. axial-flow fan, delivers 31,000 cu. ft./min. at distances of up to 60 ft. The inverted 'tear drop' discharge head is specially designed to provide large air volume at the top of the pattern and a low volume of air from the bottom of the outlet, below fan level. This provides uniform air pattern throughout the swath. Adjustable air deflectors, together with 200° rotation of the unit, allow the grower to tailor the discharge pattern to suit wind conditions and the terrain.

The new hydraulic control is mounted at the front of the sprayer



The John Bean 'Aircrop' spraying attachment provides all the advantages of air-type spraying even for growers with limited acreages

and a quick-acting spray cut-off valve and remote cable control for adjusting air deflectors are all located within easy reach of the driver. Power for the fan is provided by a 25-h.p. engine.

Another model, the smaller 8-RC attachment, delivers 12,500 cu. ft./min. through a blower unit equipped with a 21-in. axial-flow fan. This is recommended for use with sprayers equipped with pumps that deliver 7 or more gal.

For Spraying Vines and Fruit Trees

The 'Zero-Fifty' mistblower provides a new approach to spraying in low volume. This machine is capable of spraying in the form of a fine mist volumes from 50 gal. per acre down to 3 gal. or lower. It is offered in two forms—with a mounted tank of 20 gal. capacity, and with a trailer tank of 100 gal. capacity. The former gives increased mobility, as it is not necessary to stop and disengage the p.t.-o. before turning. During turning, the valve controlling the spray fluid can be turned off, but no stoppage of the tractor is necessary and the fans can be left running.

A compressor, driven by 'V' belts, delivers air at a controlled pressure of 55 lb./sq. in. into the main airline, which has a branch fitted with a pressure-reducing valve to deliver air at a lower pressure to the liquid tank; the main airline is connected directly to the spray nozzles, where the liquid is atomised. By pressurising the tanks an accurate rate of flow of spray liquid to the nozzle booms is obtained.

The '903' tricycle tractor

The nozzles are designed so that the air comes in violent contact with the spray liquid, so causing it to disintegrate and emerge from the nozzle as a very fine spray. The power of this machine can be appreciated from the fact that there are two centrifugal fans which deliver 10,000 cu. ft./min. at a velocity of 135 m.p.h. This produces the ideal droplet size for all application rates.

A Tricycle Tractor

Designed to meet the special requirements of the North American market, a tricycle row-crop tractor fitted with a 40-h.p. diesel engine has been introduced by the David Brown Co. after extensive field testing in California.

The '903', as the tricycle model is to be known, is specially intended for row-crop cultivation in maize, sugarcane or cotton, which require ample ground clearance for working over the growing crops. By using large-diameter tyres, a clearance of over 2½ ft. has actually been obtained. Manoeuvrability is so good that sharp turns can comfortably be made and the independent wheel brakes can be used to assist on the tightest corners.

The first consignment of these new tractors is going to California and Mexico for working in dry dusty soils. The machines have a special type of bearing to prevent the infiltration of dust. Similar precautions have been taken in the design of the fuel system.

Use is made of the high ground clearance and the open space between front and rear wheels for the mid-mounting of implements which can be controlled through the hydraulic system. This is in addition to the normal rear 3-point hydraulic linkage.

In order to allow independent control of the rear-mounted and mid-mounted implements, the normal lift mechanism has been replaced by a twin selector valve in the hydraulic system, operated by two separate levers. Thus, on entering rows, the centre and rear implements can be brought into operation in succession at the same point and can be lifted in the same way.

The tractor-mounted 'Zero Fifty' mistblower with a 100-gal. trailer tank

Rapid Moisture Determinations

A machine for the rapid and reasonably accurate determination of moisture in seeds, cereals, beans and pulses, tobacco flour and other types of ground agricultural produce is just what is wanted by the practical man. Using the 'Hydrofix' moisture meter, the whole operation takes less than a minute and the reading is accurate to ±0.1 to 0.4%. The sample container is filled with a weighed amount of the material—about 20 g. being required—the cell is then attached to the instrument and the reading on the scale is noted. For some materials, this reading gives the moisture content directly; for others, reference to a graph will be necessary, but that is all.

The instrument has been designed on the basis of the latest discoveries in the field of electronic research. The operating principle is the determina-

The multi-position handle of the lightweight Bolens chain saw makes it extremely easy to handle in any cutting position

tion of the dielectric constant by resonance indication, using a light-transmitting quartz crystal. The instrument can be calibrated for a single material and conversions of the readings can be made according to a graph.

The instrument is of rugged, all-metal construction and is designed to stand rough handling. It can be supplied for ordinary mains supply, or for battery or mains operation, or it can be used with d.c. by fitting a special adapter. It is a portable instrument suitable for produce-sampling in barns, warehouses or silos and in breweries or factories; it has particular value in the buying and selling of produce containing from 0–40% of moisture.

A Grain Drying Nomogram

A better understanding of the problems involved in grain drying may be obtained with the aid of the ScotMec grain-drying nomogram, copies of which may be obtained through our Reader Service.

With the aid of this chart, it is possible to determine the total power consumption, the drying time in hours, the rate of flow of air and the temperature necessary to dry a given quantity of grain to the required degree of dryness. The exact rating of the heater needed for a specific performance can also be ascertained.

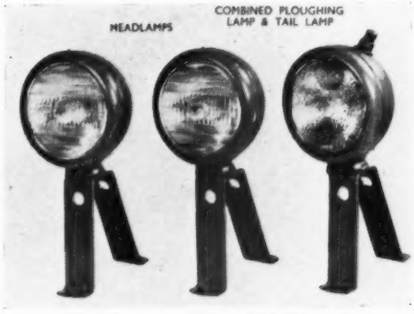
The ScotMec 5-ton grain drier is a self-filling, fast-drying, self-emptying unit, which is completely enclosed and so is vermin-proof. It is fitted with a dual-purpose blower, which not only provides the air required for drying, but also can exert sufficient pressure to send the dried grain to the granary. The air may be heated by an oil burner, an electric heater or by waste heat.

A New Chain Saw

The multi-position handle of the lightweight Bolens chain saws makes it extremely easy to handle in any cutting position—an important point in clearing up tangled undergrowth which cannot be moved. Even ' nosecuts ' are easy because of the saw's perfect balance and controllability. It is claimed that it is possible to work all day with this mechanical saw without excessive fatigue.

There is plenty of power for the fast smooth cutting of heavy timber; the centrifugal clutch eliminates kick-back and as the exhaust is not directed at the ground, no dust is blown up.

This new mechanical saw is produced by the Bolens Products Division of the Food, Machinery and Chemical Corporation, U.S.A.



The Lucas tractor lighting set

Tractor Lighting

Lucas have made it possible to ' catch up on the weather ' with lighting sets which ensure that darkness no longer limits the working hours of a tractor. Model No. 202 comprises two headlamps (each incorporating a pilot bulb which act as sidelamps), two rearlamps which provide combined tail and number plate illumination and the rearflood lamp No. 1405 as an optional extra. This lamp has been specially designed to give the best possible area when ploughing, harrowing and cultivating is carried out at night during hours of darkness. It has an integral rubber-covered switch which is easily accessible to the operator when using implements.

Water Supply

The Pegson-Marlow multi-purpose centrifugal self-priming agricultural pumps can be used for a wide variety of jobs about the farm or plantation with a minimum of attention and maintenance. Incorporating a patented diffuser priming system which ensures positive and automatic priming, the pump will evacuate air from suction lines of up to 25 ft. vertical depth and then deliver high quantities of water where it is wanted.

Water can be pumped from nearby or remote streams, ponds, rivers or wells for the daily needs of stock and to provide water supply to the farm and other buildings and for instant defence against fire. The high-pressure jet, lacking in ordinary water systems, will dislodge sludge, swill out refuse from sheds and barns and wash down farm machinery. The pumps can be brought into action quickly to dewater flooded fields, silos and ditches and also to keep foundations, cellars and building excavations dry.

Pegson-Marlow pumps are suitable for operating most types of sprinkler systems and will work without attention. There are also high-capacity pumps for flood and ditch irrigation.

The pumps may be used to fill spray

tanks or water carts within a matter of minutes. Pumps can also be supplied by this company in bronze for handling a wide range of insecticides and chemicals for pest control and fertilising.

A Row-crop Sprayer

A standard Allman 'Speedispray' has been converted for use in tomatoes and soft fruit for growers in the Channel Islands.

The machine is fitted with an Allman R.V. 10 'Rollervane' pump; the special boom assembly is mounted on the top of the tank, so giving at least 4 ft. 6 in. clearance. Six droplegs are provided, which are adjustable both for height and for row width.

The standard 'Speedispray' boom equipment can be used for ground crop spraying either with 12 fan-type nozzles or with three 'Wideangle' nozzles.

The Allman 'Speedispray' as converted for spraying row crops in the Channel Islands

A Small Gang Mower

At this year's Royal Show Ransomes exhibited a lightweight gang mower which appears to be ideal for keeping sports grounds and other large areas of turf in perfect condition.

The 'Junior' power gang mower consists of a power unit, the well-known Mk. 6A verge cutter in standard form, a trailing seat, trailing gear and two 'Junior J5' cutting units.

This machine has an overall width of cut of 5 ft. 6 in. and it is claimed that it will cut 8 acres in 4 hours, using only a gallon of petrol—a remarkably economical performance. The tackling of awkward corners is easy, as the verge cutter can be uncoupled and used as a single mower.

The outfit is very manoeuvrable and speedily adjustable, for in less than 3 minutes, using no spanners or special tools, it can be transformed from a cutting to a transporting position and driven under its own power through narrow openings or into an average-sized shed. Its overall width during transporting is, in fact, only 38 in.

Fertiliser Placement

Correct placement of a fertiliser mixture ensures the concentration of the plant foods just where they can be most effective. This will reduce the loss through the fixation or immobilisation of certain elements, and losses through the leaching of the more soluble elements which occurs when the mixture is broadcast or ploughed in uniformly. The best use is made of the fertiliser and little is wasted.

The 'Kestrel' fertiliser dispenser is a manually-operated injector, which, it is claimed, can reduce fertilising costs by as much as 50%. It is a simple machine, made of strong lightweight materials; it is easy to operate and there are no loose parts. The machine will not corrode if it is cleaned each time after use—a simple operation, as it does not have to be dismantled.

These machines are being used to fertilise tobacco and other crops in Canada, India, Pakistan, Malaya, Indonesia, Turkey, Tunisia, and in many other parts of Africa.

A Wheelbarrow Power Sprayer

The H. D. Hudson Mfg. Co., of U.S.A., announces a new line of 'Defender' wheelbarrow-type petrol-driven power sprayers. These have a piston pump that discharges up to 2½ gal. per min. at any pressures from 20 to 250 lb. The pump has spring-loaded valves with nylon seats and disks. The galvanised steel tank has a capacity of 17½ gal.

The 'Defender' wheelbarrow-type, petrol-driven, power sprayer

Spray materials in the tank are kept agitated by the power-jet system, which introduces liquid at full pressure through two jets at the tank bottom. The frame is made of strong channel steel and has plastic hand-grips. The machine is supplied with 12½ ft. of spray hose and an adjustable power gun.

Three models are available: No. 25175 has single wheel with pneumatic tyre; No. 25170 has two wheels with pneumatic tyres, and No. 25174 has two wheels with cushion tyres.

Diesels for India

The Perkins P6(V) diesel engine for vehicles is now being made in India, where Simpson & Co. Ltd. have just tooled up for the manufacture of 6,000 engines a year by flow-line production methods in a newly equipped factory covering 250,000 sq. ft. This is a remarkable achievement, since this engine has nearly 1,800 component parts, of which all, except 20 mainly proprietary items, are now manufactured in India.

A Ransomes 'Junior' power gang mower at work

Agricultural Chemicals

Insecticides, fungicides and weedkillers: lime-pelleted seed and a protective seed dressing

Control of Coffee Pests

A concentrated insecticide, based on dieldrin, is now offered for the control of the white coffee borer and the pheidole ant.

The product is known as ' Dilstan EC 15 '. The method of treatment against the pheidole ant is as follows: 2 pt. of the product are mixed with 4 gal. (1 debbi) of water. This is sprayed at the base of the trees 12 in. above ground level or it may be applied with a brush and the soil round the base of the tree may also be sprayed for a distance of 12 in. The treatment must be thorough so as to leave no path untreated along which the ants could travel.

Treatment against the white coffee borer is much the same except that the product need only be half as strong, with the result that 4 gal. of spray will treat about 120 trees at a time, the treatment being repeated twice a year.

In order to indicate which trees have been treated, the spray can be coloured by adding malachite green or methylene blue to the spray mixture. The makers add an important note which should be on every agricultural chemical of a poisonous nature. It reads: ' *Do not smoke during spraying operations*'. *The danger lies in the fact that the fingers handle the cigarette.*

*

Make More Silage

Every farmer in this country knows that he has got to cut his feeding costs. There are two main ways:

1. Feed indoors for a shorter period. This can be done by using nitrogen fertiliser on grassland, to give later grazing in autumn and an earlier bite in spring.

2. Replace a large part of the expensive purchased concentrates by cheap grass silage.

For bulky, leafy crops of silage apply 3 cwt. sulphate of ammonia or 4 cwt. 'Nitro-Chalk' per acre about one month before cutting. If a compound fertiliser is required, apply CCF No. 1A instead at the rate of 3–4 cwt. per acre. This contains 12% N, 12% P_2O_5 and 18% K_2O.

The feeding value of well-made silage may be almost as high as that of the grass from which it was made; 80–100 lb. of such silage will supply maintenance and produce 2 gal. of milk per day from each cow. There is, in fact, no better basis for profitable winter milk production. Concentrates will be required for yields above 2 gal. per cow, but the amount fed should be very carefully controlled for maximum profit. In the same way 80–100 lb. of silage per day can provide the complete ration for fattening cattle, and 6–10 lb. per day is a suitable ration for in-lamb ewes.

*

Control of Cleavers

For many years there has been an urgent demand for a weedkiller which can be applied with ease and safety to control hormone-resistant weeds in cereals. The need has been emphasised by the fact that several hormone-resistant weeds are among the most important to the farmer. An outstanding example is cleavers, for wherever this weed is present, harvesting is impeded, grain quality is lowered, yields may be reduced and grain cannot be approved for use as seed.

' Cleavex ' is a new weedkiller which is a big advance in the control of cleavers and many other hormone-resistant weeds.

Damage done by the white coffee borer

Unlike the majority of contact weedkillers, it is most effective when used at low volume, any good standard sprayer being suitable. It is cheap to apply and more economical than the DNC weedkillers, normally used for the control of hormone-resistant weeds. It is estimated by Bayer Agriculture Ltd. that ' Cleavex ' saves 12*s.* per acre.

' Cleavex ' is recommended for the control of weeds, in winter and spring wheat and winter barley. Most annual weeds are best controlled when they are young and provided the crop is between 4 in. and 9 in. high, spraying should take place immediately after most of the weeds have emerged. This weedkiller is stated to be harmless to game birds and livestock.

*

A 2,4-D Selective Weedkiller

' Fernesta ' is a liquid hormone-type weedkiller containing the mixed iso- and n-butyl esters of 2,4-D. It will suppress—without harm to the crop—the majority of broad-leaved weeds in wheat, barley and sugar-cane and certain shrubby or woody weeds in natural pasture and scrubland.

Pound for pound of active ingredient it is a more powerful weedkiller than either the sodium salt or amine of 2,4-D or of MCPA. The margin of safety to crops is, however, narrower and the principal uses for ' Fernesta ' are to suppress broad-leaved and woody weeds, some of which are resistant to the sodium and amine salts.

For the treatment of weeds in wheat and barley ' Fernesta ' should be applied at rates of $\frac{1}{4}$ to $\frac{2}{3}$ pt. per acre (350–390 c.c./ha.), according to the degree of the susceptibility of the weeds present.

For the treatment of weeds in sugar-cane ' Fernesta ' should be applied at the rates of $1\frac{1}{4}$ to 4 pt. per acre (1.75–5.5 l./ha.), according to the degree of susceptibility of the dominant weeds to hormone weedkillers. It may be applied as a high- or low-volume spray, by ground or aerial equipment, but the usual method of application is by means of a knapsack sprayer.

' Fernesta ' is also effective against many weeds of pastures, *e.g.* thistles, but in many sub-temperate, tropical and sub-tropical countries woody weeds form the main problem on grassland. If leguminous plants form an important constituent of the sward, spraying with ' Fernesta ' cannot be advised and ' Agroxone ' should be used instead to suppress susceptible herbaceous weeds.

*

Pink Bollworm Quarantine

Since its first detection in 1917 in the Texas cotton belt the pink bollworm has been a scourge in the areas to which it spread and a threat to all cotton farming districts of the U.S.A. Field sanitation, strict planting and harvest date controls and rigid quarantines have slowed the advance. Fumigation of cotton seed, cotton linters and all other items connected with cotton processing has been a major factor in suppressing further spread.

' Eston ' methyl bromide is one of the most effective agents for universal elimination of pink bollworm from cotton products and machines destined for shipment outside the quarantined zones.

Cotton seed, baled cotton, cotton linters and fibre derivatives may be fumigated with methyl bromide in approved enclosures, such as steel tanks, vaults, freight vans or under treated tarpaulins. Mechanical cotton pickers and used ginning machinery for shipment outside quarantined areas must be fumigated with methyl bromide, usually under treated tarpaulins.

*

Ceresan

In a previous note (WORLD CROPS, 9, 396) an account was given of ' Ceresan ' WS, which in error also included some recommendations regarding ' Ceresan ', an entirely different product.

Briefly, ' Ceresan ' WS is a dry seed dressing, specially recommended for the control of blackleg and wireworm in sugar-beet, fodder-beet and mangolds and it is also recommended for grass-clover seed mixtures. This is a dual - purpose dressing containing gamma BHC and an organo-mercurial compound.

' Ceresan ' is simply an organo-mercurial seed dressing intended for the control of seed-borne diseases in cereals, though it could also be used on the seeds of root crops, but only for the control of blackleg and not for wireworm.

*

Control of Bracken

The chemical control of bracken now appears to be possible. Bracken control has hitherto been by regular twice-yearly cutting to wither the root structure and from three to four years is normally necessary to gain complete control of the pest.

A chemical made by the American Paint Co. has given encouraging results. Because of the difficult terrain, an Augusta Bell helicopter fitted with 40 nozzles was used and concentrations were varied to test the effectiveness at different strengths. The chemical, which is now being made for the American Paint Co. by A. H. Marks Ltd. is claimed to operate on and destroy the root structure. With mechanical control it takes 12 weeks' work to clear 200 acres annually, but chemical control from the air, it is said, took only a few hours.

*

For Fighting Bugs

' Tetron-50 ' kills many types of soft-bodied, sucking insects such as the common species of aphids, spider-mites, thrips and also insects with heavy waxy coatings, such as mealy bugs and woolly aphids. It may be applied safely to fruit trees, soft fruit bushes, vegetable crops, field crops, alfalfa and cotton.

The product contains 20% tetra-ethyl pyrophosphate (TEPP) plus a special solvent and emulsifier. It is a powerful contact insecticide but with little residual effect it requires repeated applications. The lack of any toxic residues, however, allows spraying to be carried out right up to the harvesting of fruits and vegetables.

This insecticide spray is claimed to give bigger stands, more vigorous growth and larger crops.

Reader Service

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Molybdenum

New techniques have been developed for economically correcting ' moly ' deficiency and defective nodulation in legumes growing in acid soils. The use of molybdenum superphosphate and lime-pelleted seed has shown promise in establishing legumes in over-acid soils (*p*H 5.5 or less), according to studies conducted by a research group in the C.S.I.R.O. Division of Plant Industry at Canberra, Australia (*Rural Research in C.S.I.R.O.*, December 1956).

These studies showed that the quantity of lime required to induce nodulation of plants is considerably less than that needed to correct ' moly ' deficiency. As a result, it was found that the combined use of moly superphosphate and lime-pelleted seed successfully solved both soil problems at considerable savings. Molybdenum is obtainable from the Climax Molybdenum Co., U.S.A.

*

Potato Blight

A new fungicide has been produced by the Murphy Chemical Company Ltd. for the control of potato blight, which solves the problem of how to control blight in potatoes with copper —which is still unchallenged as a protective fungicide—without causing the hardening of the foliage, known as copper ' shock '.

The new product, ' Dufox ', contains copper (50%) for protection and mercury (0.6%) for eradication. It is claimed by the manufacturers that the combination of these two fungicides, in these proportions, makes it possible to reduce the amount of copper in a spray without any reduction in its fungicidal efficiency. It thus costs less per acre than straight copper sprays.

The product may be used either in low volume (3 lb. in 25 gal. per acre) or as a high-volume spray (3 lb. in 100 gal. per acre). The crop should be sprayed before the plants meet across the rows and the treatment should be repeated at two or three intervals, depending on the weather conditions. When blight warnings are given, the plants should be sprayed immediately.

The Murphy Pest and Disease Chart for 1957, which is a valuable guide to the indentification and control of horticultural pests and diseases has been received.

WORLD CROP REPORTS

INTERNATIONAL REPORTS

Almonds

Commercial production of almonds is expected to reach a near record this year. The expected crop is 90,900 short tons, shelled basis, or approximately double that of the past two seasons, when crops were short in the Mediterranean area. The five-year average for the period 1950–54 is 81,700 tons.

Estimated production for Italy, the largest producer, is 44,000 short tons, nearly four times as large as the 1956 freeze-damaged crop and about 12% greater than the five-year average of 39,300 tons. Spain similarly looks forward to an above-average harvest. At 30,000 tons, shelled basis, Spain's new crop will be 50% larger than the 1956 crop and 3,900 tons above the 1950–54 average.

Portugal, too, anticipates a good almond crop for 1957. The forecast is for 5,800 short tons of shelled almonds—nearly twice the estimated 1956 harvest and well above the 5,300-ton average for 1950–54. A fully average crop, and possibly larger, is reported from Iran.

Citrus

Dry weather has been the predominant factor in most citrus-producing areas during the 1956–57 season. Many areas are reporting large crops, but in some cases dry conditions have produced small fruit.

Nearly all areas report increased crops, largely because new plantings are coming into bearing and giving increasing yields. Almost all major producing areas reflect a continuing increase in new planting.

Despite a severe reduction in the 1956 orange crop in Spain, *world orange production will set a new record, about* 74% *above the* 1935–39 *average.*

World production of oranges and tangerines from 1956 crops totalled more than 350 million boxes, an increase from last year of 4 million boxes. All major orange-producing sections of the world, except the Mediterranean area, have reported increased production.

In the Mediterranean, Spain's production was heavily down, owing to the early 1956 frosts, with some decreases also in Israel and Egypt. Australia, too, reported a decrease, largely as a result of unfavourable weather.

World production of *lemons* in 1956, it is estimated, will be about 3½ million boxes above last year. The greatest increases were in the U.S.A. and Italy, where crops in each are estimated at 1 million boxes above 1955. Turkey's production increased about 150,000 boxes over 1955, largely as a result of new plantings coming into bearing, while Israel and Spain both reported sharp reductions from 1955 yields.

Grapefruit production in the world in 1956 dropped about 2 million boxes below that in 1955. The crops of most important producing areas, with the exception of the U.S.A., have been reported at about the same level as in 1955, but in the U.S.A. they are 2 million boxes below 1955.

REGIONAL REPORTS

Dominican Republic

Some of the *sugar* mills closed down their grinding season in May and grinding finished generally by June except for two mills on the north coast which started grinding in April. Although yields have been very good, it is estimated that total production will still be short of 800,000 tons. Planting has been extended but, although next year's production will be increased by some 100,000 tons, informed circles do not believe that the 1957 target figure of 1 million short tons will be reached before 1960. With a buoyant world market and sugar in short supply, prices have been highly remunerative and have given a much needed fillip to what was a somewhat strained general economy.

This year's *coffee* crop was considerably affected by drought conditions. Shipments of the 1956–57 crop were estimated at 213,100 bags of 75 kilos compared to 411,300 bags exported in the 1955–56 season. Small stocks are being held in reserve in anticipation of rising foreign demand. Early indications are that the 1957–58 crop, beginning in August, will be excellent due to improved growing conditions, larger areas under cultivation and better attention to plantations.

Despite drought conditions in the early part of the year, which retarded the maturing process, the volume of the *cocoa* crop, which was harvested in May and June, was larger than in many previous years—about 475,000 bags of 70 kilos each, which is double the previous year's figure. Under more favourable weather conditions in March and April, production might have attained 600,000 bags.

Although major *tobacco* harvesting operations were then over, the abundant fainfall in May and June produced a quantity of second-growth leaves of very good quality. Production for the season is estimated to reach over 300,000 quintals.

Dry spells in the early normal *groundnut* planting season made resowing necessary in the most heavily affected northern areas. The second crop of the year was expected to come in at irregular periods from July to September, as successive plantings come to maturity.

Lack of rainfall retarded rice-planting operations for the 1957 crop. Cutting was beginning in June of some early planted land but no supplies of consequence were expected before the end of July.

Mexico

The latest estimate for the 1957–58 *cotton* crop is 1,896,000 bales. Of perhaps greater importance is the estimate of the number of bales available for export during 1957 which on the above crop estimate is 1,896,000 plus 200,000 bales (carry-over from 1956) less estimated home consumption of 475,000 bales *i.e.* 1,621,000 bales. There must in consequence be a considerable decline in exports as compared with last year when, in spite of a smaller crop, exports reached 1,834,309 bales, a figure made possible by the large carry-over from 1955.

It is estimated that this year's *coffee* crop will make it possible to export 1,400,000 sacks to a value of 1,500 million pesos compared with 1.2 million sacks worth 926.1 million pesos last year. *Sugar* production up to 22 June was 1,005,116 metric tons as compared with 744,129 metric tons during the 1956 season. Mexico will thus be able fully to cover her export quotas, instead of importing

sugar, as was the case last year. *The* wheat *crop for this year is expected to reach 1.4 million tons, which, together with the carry-over from last year, should enable Mexico, for the first time in history, to become an exporter of wheat.*

Costa Rica

The 1956–57 *coffee* crop continues to show every indication that it will break all records. Latest estimates from the Central Bank place the total crop at 740,000 quintals (1 quintal = 100 lb.) as compared with the previous record of 738,000 quintals for the 1954–55 crop. Whilst it is too early to make any definite predictions regarding the 1957–58 coffee crop, farmers are optimistic and consider that the coming crop will be even greater than the 1956–57 crop.

Latest estimates of *banana* production for 1957 total 7.9 million stems which is an improvement over earlier calculations of 7 million. The National Production Council reports that preliminary indications show that bumper crops of the country's three staple foods, *rice*, *beans* and *corn*, are now being harvested. It is announced in the local press that the current *cocoa* crop in the Limon Province has sustained severe losses owing to heavy rains. Limon is the major cocoa-producing area in the country. Unconfirmed estimates place losses as high as 75% of the crop, which, if confirmed would add to the already considerable financial difficulties faced by cocoa producers.

Cyprus

The 1956 cereal harvest was greater than any previously recorded and almost certainly an all-time record. Production of wheat was about 80,600 tons, compared with the previous record harvest of 69,940 tons in 1954. This was entirely due to higher yields, the area under cereals being no more than average and rather less than in the previous year.

Imports of fertiliser reached the record figure of 68,250 tons. There were also marked increases in the use of insecticides and selective weed-killers. *It seems that the cereal farmer has now gained confidence in the use of selective weedkillers and has adopted them as an indispensable aid in his war against weeds.*

In spite of considerable loss caused by excessive summer heat, the production of grapes was good, though lower than the previous year.

A significant development for the future of the citrus industry was the demonstration of a cheap and effective method of controlling Mediterranean fruit fly.

Peru

Prospects of the current cotton crop have deteriorated in certain areas due to losses from pests. Fortunately, this will be compensated by a considerable improvement in yield from the Canete valley. The Cotton Chamber estimates that total production will probably be about 2,350,000 quintals or only 100,000 quintals less than the record 1955–56 crop.

The Peruvian Corporation announced on 13 June a new programme of development of the Perene Colony, an estate of about 1 million acres belonging to the Corporation in the jungle area of the Eastern Andes. The plans provide for an expansion of coffee growing and timber production and the exploitation of other tropical products.

El Salvador

Coffee usually provides more than 80% of the country's exports. The 1956–57 harvest was the biggest the country has ever known, 1.2 million bags of 69 kg., mainly due to the increased use of fertilisers. In spite of this excellent result, there is some anxiety about the future for coffee.

The 1956–57 crop of *cotton* was about 140,000 bales of 5 cwt., obtained from a rather smaller acreage than was sown in the previous year. Here again fertilising and spraying with insecticide are essential.

The crops of *maize* and *beans*, the staple foodstuffs, were adequate. There was an abnormally large crop of *sugar* and some was exported.

England and Wales

Considerable progress was made with the harvesting of cereal crops under difficult conditions. Assuming normal weather conditions will prevail during the remainder of the season, yields per acre are expected to be above the average of the preceding five years for wheat, about average for barley, but below average for oats. *Blight in potatoes is widespread;* the yield per acre of potatoes is expected to be somewhat below average. Root crops made good growth and average yields are expected. Haymaking has been protracted and difficult in some upland and northern areas.

The first few days of August were fine and rather warm, but thunderstorms and heavy rain followed and lasted until the middle of the month. The weather then became warmer and drier, but this was again followed by gales, heavy rain and thunderstorms. The last few days of the month were mainly fine with increasingly sunny periods.

Cereal and pulse crops.—Considerable progress was made during the month with the harvesting of cereal crops, but operations were retarded by storm damage; and the uneven ripening of some crops is causing difficulty. Forecasts of average yields per acre as at 1 September, made on the assumption of normal weather conditions during the remainder of the season, are given below:

Wheat.—The quality and condition of harvested crops are reported to be good in some eastern counties and, in the main, fairly good elsewhere. There are reports of some shedding and sprouting. Much of the spring wheat is slow to ripen. The yield is forecast at 25.3 cwt. per acre.

Barley.—The quality and condition of harvested crops are mainly fair. Some crops have been badly lodged, and shedding and sprouting are reported. The yield per acre is now expected to be 22.5 cwt.

Oats.—The majority of the harvested crops are only of moderate quality and condition. Standing crops have suffered considerable damage from the weather; lodging, shedding and sprouting are frequently reported. The yield per acre is now forecast at 18.9 cwt.

Mixed corn is expected to yield 19.6 cwt. per acre.

Rye is a good crop on the whole. The yield is forecast at 19.2 cwt. per acre.

Acknowledgment is made to *For. Crops & Mark.* and to *Spec. Reg. Inform. Services* for much of the information contained in the above reports.

The item on England and Wales is abstracted from the monthly report of the Ministry of Agriculture, Fisheries and Food on agricultural conditions as at 1 September.